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THE MANUAL OF PRACTICAL POTTING

EDITED BY C. F. BINNS

FIFTH REVISED EDITION

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THE MANUAL OF PRACTICAL POTTING

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SPECIALLY COMPILED BY EXPERTS

AND EDITED BY

CHARLES F. BINNS

FIFTH EDITION

EXTENSIVELY REVISED

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PRACTICAL POTTER

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LONDON

SCOTT, GREENWOOD & SON

"THE POTTERY GAZETTE AND GLASS TRADE REVIEW" OFFICES

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PREFACE TO THE FIFTH EDITION

THE utility of the *Manual of Practical Potting* is clearly shown by the demand for a further edition. Since the publication of the last issue considerable progress has been made in the manufacture of pottery, thereby necessitating the revision of the "Manual" so as to bring it quite up-to-date. This has been done, the present volume being the result. There are numerous technical treatises dealing with the theoretical considerations relating to ceramics already on the market, but in this work the original method has been adhered to (as in the former editions), of presenting the information in as plain and non-technical a manner as possible. New recipes have been incorporated along with a number of useful sections and portions of the work on *Ceramic Technology*, so that the "Manual" may now be said to represent modern practical potting. To those engaged in the ceramic industry the recipes will be found to be not only good in themselves, but many may also be used as a reliable groundwork on which to base further experimental work. It is very important, especially in a work of this kind, to draw the reader's attention to the fact that due regard should be given to those parts other than the recipes. It is only when subjected to the right treatment during the various processes connected with the production of ceramics, that satisfactory results are obtained even with the best recipes. A knowledge of such treatment can only be acquired by personal study and observation.

LONDON, *March*, 1922.

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INTRODUCTION

THE RISE AND PROGRESS OF THE POTTER'S ART IN ENGLAND

No branch of manufacture presents so intimate and ancient an alliance between art and utility as that of the potter, whose earliest productions take their rise from a date which, in the Eastern Hemisphere, is lost in the darkness of remote antiquity. The ceramic art, both in its theory and practice, unites a combination of qualities unknown in any other expression of human skill. No other industry presents so many divers considerations, all of them of the utmost interest, and each one rich in economic and scientific application.

Finding its materials at or near the surface of the earth, pottery displays manufactures the most simple and yet the most varied—the easiest to fabricate, and, though fragile, of incomparable durability. The products of these substances are absolutely endless in their variety, while in their most successful exponents their beauty may be pronounced as matchless.

Every species of form, from the classical severity of the early Greek period to the florid luxuriance of the wares of Saxony, France, and, one may now fairly add, England, here finds a fitting and worthy medium.

A material which science teaches to present the most lustrous surface, which is solid, imperishable, and admirably qualified for the application of varied and brilliant colouring, offers such inducements to the painter that even the pencil

of the glorious Raffaelle himself was occasionally employed in its decoration.

Without doubt the potter's art had its rise in the land of Egypt, from whence it travelled to Greece; and to the refined taste of that country the ceramic industry is indebted for its most beautiful shapes. The Romans did much to diffuse the making of pottery in the countries conquered by them, in this country especially. Ever since the Roman invasion potteries have had an existence in different parts of England, particularly in Staffordshire, as is evidenced by the quantity of pottery fragments that have been upturned in the course of ages.

The term "pottery" is derived from the Latin *poterium*, the name given by the Romans to drinking vessels; but this does not convey any signification denoting either form or substance.

The word "ceramic," the generic title by which works in this department of art manufacture are now known, is derived from the Greek. It primarily signifies the "horn of an animal." It has obtained its generally recognized signification from the early use of horns for drinking purposes, which in their turn gave place to articles made from plastic materials.

For many years the manufacture of pottery was of the most primitive type; but it gradually came to be regarded as the vehicle for artistic taste, and, in the mediæval age, attracted the attention of famous artists on the Continent, as is evidenced by the lovely works, still extant, associated with the honoured names of Palissy and Luca della Robbia, which for all time will be regarded as masterpieces.

Although the potter's art flourished in China prior to the Christian era, in this country very little was known of it until the reign of Elizabeth, who endeavoured to found potteries, with but indifferent success; indeed, little of

importance was accomplished until the close of the sixteenth century. The first articles of which we find mention made were butter-pots and "tygs," the latter a peculiar species of handled drinking vessel. Ornamental dishes appear to have been made at Burslem, "the mother of the potteries," as early as 1650, the glazing of which was effected by means of lead. Thirty years later the purest accident led to the substitution of salt for lead in this particular, the first use of which was made by a potter named Palmer. The ware when salt glazed was known as "cranch ware," and the manufacture proved a source of considerable employment.

The first attempts that were made to imitate the work of the Eastern potters was a decided failure; but in 1690 two brothers, named Elers, discovered a bed of fine compact clay at Bradwell Wood, near Burslem, which enabled them to produce with exact success a fictitious Japanese ware.

The use of calcined and ground flint as an ingredient of pottery is attributed to the younger Astbury in 1720, and led to great and highly important improvements in the wares in Staffordshire. The new material was used in combination with pipe-clay and sand, coloured with oxide of copper and manganese.

A year later another innovation was introduced by Ralph Daniel, of Cobridge, from France, in the shape of moulds of plaster of Paris, which speedily became adopted by the English potters.

The forms and patterns of the wares produced at this period were generally obtained from the silver plate of the time; the colours of the bodies were known as drab or cream-coloured and white. Painted ware of a crude type also came into general use a few years later; but it was not until the middle of the century that printed ware was introduced.

Such was the condition of English pottery manufacture in the district specially identified with the art when another Palissy arose in England in the person of the great Wedgwood, who was born in the year 1730. At an early age he worked as a thrower at the potter's wheel in his elder brother's manufactory; but the state of his health compelled him to relinquish this occupation, and he afterwards followed the natural inclination of a mind richly endowed both with ingenuity and enterprise. In the year 1759 he succeeded in making a rich cream-coloured ware, by which he quickly attained a high degree of celebrity, so much so that he at once became the royal potter. At the same time Wedgwood sold his ware at a price which brought it within the means of general consumption both at home and abroad. How Josiah Wedgwood enhanced the reputation of the Staffordshire Potteries is a matter of common knowledge. Suffice it to say, that since his day the art in the district has shown no retrograde movement; on the contrary, it has gone on increasing year by year in excellence, till at the present time it towers above any of its foreign competitors.

In the year 1700 the whole of the Pottery district only contained fifty ovens, the small holding capacity of which permitted only a very restricted output. Again, in the year of the Great Exhibition, 1851, which did so much to encourage the potter's art, the number of fictile establishments in Staffordshire only numbered one hundred and thirty-three; while at the present time this has increased threefold.

By no means the least important of the improvements that have taken place in the pottery industry since the earlier editions of this work were issued are centred round the methods of treating the raw materials, much greater attention being devoted nowadays to the scientific control of supplies. Incidentally, this has led to an increase in the

types of bodies, *e. g.* there are now distinct and separate body mixtures for domestic, sanitary, medical, chemical, electrical and stoneware pottery, in the successful production of all of which the technical requirements are rigid and severe. During the Great War considerable attention was devoted in Great Britain—more especially by the research chemists, whose work was facilitated by Government grants—to the production of hard porcelain bodies, and the result of that work has led to considerable improvement in the production of chemical and electrical pottery.

In the preparation of the modern pottery bodies, the developments have embraced a notable extension of cylinder grinding; the construction of the larger types of blungers has been markedly improved; rotary sifters and electro magnets of the cascade type have resulted in cleaner ware; the use of a soluble decoloriser has become popular; centre-feed presses and dead-weight pumps have been re-introduced; an electrolytic press has been evolved and has proved partially successful; and pugmills, which were at one time used only for earthenware, have been very much improved and are now used to quite a fair extent in the china industry also.

Amongst the mechanical operations connected with the actual making of pottery articles there have been remarkable strides in many directions. The "jolleying" of oval pieces is worthy of emphasis, as well as the "jolleying" of china, which was at one time looked upon as impracticable. Die-pressing has been phenomenally developed, particularly in the electrical potteries. The hand-pressing of countless articles has been very largely superseded by the alkaline casting process, in both the china and earthenware industries, the newer casting installations providing special mechanical devices for the automatic filling and emptying of the moulds, thereby minimizing the attendant, unskilled

labour. This casting principle, be it noted, is not merely confined to ordinary domestic pottery bodies, but is also becoming more and more adopted for heavily-grogged mixtures, such as fire-clays and saggar-marls. Automatic dryers, on the principle of humidity control, promise to lead to far greater facility in the execution of the work of the greenhouse. Towing has replaced sponging in the production of flat ware. Mechanical bedders are now also being largely used. Saggars are being made by machinery, whereas, not many years ago, they were all being made by hand.

In connection with the glazing of pottery goods, greater attention is to-day being given to the suitability of particular glazes to fit particular bodies; and low-solubility lead glazes, as also leadless glazes, are being fairly freely used in connection with the productions of many well-known potteries. Dipping machinery—especially in the manufacture of such standardized and repetition work as tiles—is also coming more and more into force.

In the decorating departments of many of the large concerns manufacturing domestic wares, roller printing is coming very rapidly into vogue, with the result that three-colour printing has been rendered possible during recent years at only a relatively higher price than single printing. As yet, however, the direct application of more than a single colour to the ware at one operation has only been proved partially successful. The means of aerography and lithography have been very notably improved, resulting in the placing of pleasing designs within the reach of the poorer classes. Except for the better-class productions, groundlaying has fast been replaced by the air spray. Art glazes and lustres are being powerfully exploited, and altogether the range of colour treatments is infinitely larger and wider than at any previous time.

In the firing of pottery the intermittent ovens and kilns are rapidly giving way to the continuous types, such as (*a*) the chamber kiln in which the fire moves to the goods, and (*b*) the tunnel variety, in which the ware moves to the fire zone. In general, these newer ovens and kilns are gas-fired rather than direct-fired with solid fuels.

In short the modern production of pottery on a commercial scale, from the raw materials to the last touch of decoration, is tantamount to a more or less co-ordinated effort of the chemist, the engineer, the technical expert and the artist. Rule-of-thumb is fast giving way to equations and formulæ.

The potter's art has still a great future before it, not only in producing things of increased beauty and utility, but in finding employment for the teeming masses of the population of the districts specially identified with its manufacture.

THE MANUAL OF PRACTICAL POTTING

CHAPTER I

COMPARATIVE LOSS IN WEIGHT OF CLAYS, ETC., DURING DRYING AND FIRING

MANY of the materials used in pottery bodies and glazes when received at the works contain varying amounts of moisture. The quantity of hygroscopic moisture depends upon the particular material, and on the weather conditions prevailing during transit. China clay, flint, stone, bone ash, felspar and whiting are sold to the pottery manufacturer at a certain price per ton " dry," with an agreed maximum percentage of water. This arrangement is possible, as the miller or clay purifier has full control over the drying operation, so that the moisture content of different consignments should not vary to any great extent.

Since china clay undergoes treatment at the mines before dispatch, the final stage being that of drying, climatic conditions during transport must be regarded as the only admissible factor in altering the water content. On the other hand, with clays, *e. g.* ball clay, red clay, etc., which contain variable amounts of water when mined, and do not undergo any preparation, the manufacturer may reasonably expect great variations in the moisture content.

This question of the moisture content of raw materials is important and demands careful supervision; otherwise the

manufacturer will not only find himself paying for water at the rate of stone, clay, bone, etc. (Example *A*), but, if the dry method of mixing is used, he will also have considerable variation in the composition of his bodies (Example *B*).

(*A*) A load of bone ash was delivered by motor-lorry to a factory only half a mile from the mill. The mean result of several tests on samples taken from the load gave a moisture content of 19·5 per cent., as against the agreed maximum of 15 per cent. Now, one ton of bone ash containing 15 per cent. moisture would give $100 : 85 :: 20 : x = 17$ cwt. dried; whereas with a moisture content of 19·5 per cent. the yield would be only $100 : 80{\cdot}5 :: 20 : x = 16{\cdot}1$ cwt. At the rate of £25 per ton, this represents a loss of 22*s.* 6*d.* per ton load of bone ash received.

(*B*) The change in composition of a bone china body, due to variable moisture content, is illustrated in the following table.

Recipe.	Standard Moisture.	Net dry Weight.	Actual Moisture Content.	Net dry Weight.
50 bone ash . .	15%	42·5	20·0%	40·00
25 stone . . .	10%	22·5	12·5%	21·87
25 china clay . .	10%	22·5	9·0%	22·75

In addition to checking the deliveries of the raw body and glaze materials, ample and suitable storage accommodation should be provided. For instance, if borax or soda crystals are stored in a hot room, they lose a portion of the water of crystallization; on the other hand, for soda ash and pearl ash, which readily absorb moisture, dry storage is necessary.

THE METHOD OF DETERMINING THE MOISTURE CONTENT OF ANY GIVEN CONSIGNMENT.

A small glass dish, about three inches in diameter and half an inch deep, is first carefully weighed. The sample to be tested is then put into the glass dish and the weight again exactly determined. The difference of the two weighings gives the weight of the sample taken. The dish, with its contents, is then placed in a drying oven, the temperature of which must be kept at approximately 110° C. for four hours. It is then transferred to a desiccator for twenty minutes (a description both of the oven and desiccator will be found in any elementary treatise on practical chemistry). The dish, with its contents, when perfectly cool, is again weighed. It is then dried for another hour, cooled and re-weighed. This process is repeated until the weight is found to be constant. The difference between the weight before drying and the final weight represents the amount of moisture contained in the sample. The result multiplied by 100 and divided by the weight of the sample itself gives the percentage moisture content. It is advisable to take several samples from different parts of the consignment, treat them as already explained, and find the average, since the value of the test depends on the representative nature of the samples taken.

Example :—Blue ball clay ; all weights in grammes.

	No. 1 Sample.	No. 2 Sample.	No. 3. Sample.
Weight of glass dish . . .	41·95	37·35	40·35
,, ,, ,, ,, plus clay . .	104·65	137·00	109·25
,, ,, clay	62·70	99·65	68·90
,, ,, dish and clay, 1st weighing	96·75	130·10	101·70
,, ,, ,, ,, ,, 2nd ,,	94·65	124·65	97·80
,, ,, ,, ,, ,, 3rd ,,	94·25	122·80	95·95
,, ,, ,, ,, ,, 4th ,,	94·25	122·80	95·95
% loss of weight on drying	16·60	14·20	19·30
∴ Average % loss = 16·70.			

When dried at a temperature of 110° C. clays and bodies lose all their hygroscopic water. They retain, however, chemically combined water and other constituents which are eliminated by heat, *e.g.* carbon from carbonaceous matter, carbon dioxide, etc. The various gaseous products can only be expelled by heating to bright redness, at which temperature clays and bodies lose weight. (The physical and chemical changes that take place in the clay during firing are treated exhaustively in Binn's *Ceramic Technology*, 1897.)

In estimating the cost of fired bodies, the loss of weight of the different materials used must be known. The samples should be dried as previously described, transferred to a refractory vessel, passed through the biscuit oven, and re-weighed. The results are recorded as percentage loss of weight.

	% Loss in Drying.	% Loss in Firing.	Total % loss Wet-fired.
Ball clay	27·85	10·32	35·29
China clay	11·70	12·08	22·37
Flint	9·55	0·20	9·73
Stone	12·10	1·35	13·29
Felspar	11·20	0·70	11·82
Earthenware body	23·80	6·40	28·68
Bone china body	19·25	4·10	22·56

The practical utility of such results, when extended to include other materials, will be evident to experienced potters. The following examples will suffice to show their value when calculating the real cost of fired body materials.

1 ton of dry flint costs £6.

It has a loss on drying of 10% and on firing 1%.

$\therefore$ 1 ton yields $\left(\frac{90}{100} \times \frac{20}{1} \times \frac{99}{100}\right)$ cwts.

$= 17\frac{4}{5}$ cwts. when fired.

$£\frac{6}{17\frac{4}{5}} = 6s.\ 9d.$ per cwt.

or £6 15*s.* 0*d.* per ton of fired flint.

1 ton of ball clay costs £4.

It loses 25% on drying and 12% on firing.

$\therefore$ 1 ton yields $\left(\frac{75}{100} \times \frac{20}{1} \times \frac{88}{100}\right)$.

$= 13\frac{1}{5}$ cwts. fired material.

$£\frac{4}{13\frac{1}{5}} = 6s.\ 0\frac{3}{4}d.$ per cwt.

or £6 1*s.* 3*d.* per ton of fired ball clay.

CHAPTER II

SLOP FLINT AND STONE CALCULATIONS

THE standard usually adopted in buying and selling slop flint and stone is : " That a peck of slop flint or stone shall weigh 32 lbs." In practice, all slops not conforming to this weight are reduced to an equivalent number of 32-lb. pecks. Now, 16 ozs. = 1 lb., and 16 pints = 1 peck; therefore, whatever the pint weighs in ounces the peck will weigh in pounds.

The method of calculating the number of standard pecks in any given delivery is as follows : First reduce the machine weight of the consignment to pounds; then divide the number obtained by the pint weight in ounces. This will give the number of pecks by measure. These are then reduced to *standard* pecks by multiplying by the pint weight in ounces, less 20, and dividing by 12.

For instance : One ton of slop flint is received at 32 ozs. to a pint. How many *standard* pecks does this represent ?

Machine weight = 1 ton = 2240 lbs.
Divide by pint weight in ounces (32).

$$\frac{2240}{32} = 70 \text{ pecks by measure.}$$

Multiply by pint weight in ounces less 20, (32 — 20 = 12), and divide by 12 : $\frac{70 \times 12}{12} = 70$ standard pecks.

How many standard pecks are there in $18\frac{3}{4}$ cwts. of slop stone at 30 ozs. to a pint?

$$18\tfrac{3}{4} \text{ cwts.} = 2100 \text{ lbs.}$$

$$\frac{2100}{30} = 70 \text{ pecks by measure.}$$

$$\frac{70 \times 10}{12} = 58\tfrac{1}{3} \text{ standard pecks.}$$

The following table, which is calculated on the above principle, is an abridged copy of a serviceable and widely-used *Slop Flint and Stone Trade Calculator*, published by W. J. Furnival, Porthill.

SLOP FLINT AND STONE CALCULATOR

Machine Weight 112 lb to 1 cwt.		Pint 30½ ozs.	Pint 30¾ ozs.	Pint 31 ozs.	Pint 31¼ ozs.	Pint 31½ ozs.	Pint 31¾ ozs.	Pint 32 ozs.	Pint 32¼ ozs.	Pint 32½ ozs.	Pint 32¾ ozs.	Pint 33 ozs.	Pint 33¼ ozs.	Pint 33½ ozs.
cwts.	qrs.	32 lb Pecks	32 lb Pecks	32 lb Pecks	32 lb Pecks	32 lb Pecks	32 lb Pecks	32 lb Pecks	32 lb Pecks	32 lb Pecks	32 lb Pecks	32 lb Pecks	32 lb Pecks	32 lb Pecks
18	2	59½	60¼	61¼	62¼	63	64	64¾	65¾	66¼	67¼	68	68¾	69¾
18	3	60¼	61¼	62	63	63¾	64¾	65¼	66¼	67¼	68	69	69¾	70¾
19	0	61	62	63	63¾	64¾	65¼	66¼	67¼	68¼	69	69¾	70¾	71¾
19	1	61¾	62¾	63¾	64¾	65¼	66¼	67¼	68¼	69	70	70¾	71¾	72¾
19	2	62¾	63¾	64¼	65¼	66¼	67¼	68¼	69	70	70¾	71¾	72¾	73¾
19	3	63¼	64¼	65¼	66¼	67¼	68¼	69	70	70¾	71¾	72¾	73¾	74¾
20	0	64¼	65¼	66¼	67¼	68	69	70	71	71¾	72¾	73¾	74¼	75¼
20	1	65	66	67	68	69	70	70¾	71¾	72¾	73¼	74¼	75¼	76¼
20	2	65¾	66¾	68	68¾	69¾	70¾	71¾	72¾	73¼	74¼	75¼	76¼	77
20	3	66¾	67¼	68¾	69¾	70¾	71¾	72¼	73¼	74¼	75¼	76¼	77¼	78
21	0	67¼	68¼	69¼	70¼	71¼	72¼	73¼	74¼	75¼	76¼	77¼	78	79
21	1	68¼	69¼	70¼	71¼	72¼	73¼	74¼	75¼	76¼	77¼	78	79	80
21	2	69	70	71¼	72¼	73¼	74¼	75¼	76¼	77¼	78	79	80	80¾

The fractions given in the table are the nearest approximate quarter ounces; if $\frac{1}{8}$ oz. differences are required they can be readily inserted. It must be remembered, however, that the specific gravity of the material is assumed to be the same, and in this connection it is advisable to note the remarks on p. 9 concerning the calcination of flint.

THE CONVERSION OF A "SLOP" RECIPE, OR FORMULA, INTO A "DRY" RECIPE, AND VICE VERSA

In consequence of removal, structural or mechanical alterations, interruptions in the supply of the usual materials, etc., the manufacturer is sometimes faced with the problem of reverting from a " slop " or wet mixing to a dry method, or vice versa.

When in a slop state, pottery materials are used at so many ounces to the pint. The actual dry content in a pint of slop material can be ascertained in two ways :

(1) By evaporating the water and weighing the residue.

(2) By calculation.

The first method is not employed when the specific gravity of the material is known ; the result can be arrived at more readily by calculation, which is based on the relation existing between the specific gravity of the substance and the slop weight per pint in ounces.

A pint measure will hold approximately 20 ozs. of water. If one ounce of water is taken out, and a similar bulk of a substance with a specific gravity of 2·5 is added, the measure will still be full, but, if weighed, it will be found to have increased in weight by $1\frac{1}{2}$ ozs., viz. from 20 to $21\frac{1}{2}$ ozs. To increase the pint weight, therefore, by $1\frac{1}{2}$ ozs., $2\frac{1}{2}$ ozs. of material have had to be added. It follows, then, that with slop materials weighing 24, 26 and 32 ozs. to the pint respectively, the dry content, if of the same specific gravity, can be calculated :

$$\left.\begin{array}{l} \text{As } 1\frac{1}{2} : 4 :: 2\frac{1}{2} : x = 6\frac{2}{3} \\ 1\frac{1}{2} : 6 :: 2\frac{1}{2} : x = 10 \\ 1\frac{1}{2} : 12 :: 2\frac{1}{2} : x = 20 \end{array}\right\} \begin{array}{l} \text{Or in the} \\ \text{proportion of} \\ 1 : 1\frac{1}{2} : 3 \end{array}$$

In 1848, Brongniart published the following formulæ for converting wet to dry, and vice versa, when the specific

gravity of the dry material and the slop weight are known :

$$(a)\ D = (P - 20) \times \frac{G}{G - 1}$$

$$(b)\ P = 20 + \left(D \times \frac{G - 1}{G}\right)$$

where D = dry content, P = weight of pint in ounces, and G = specific gravity.

These formulæ are extremely serviceable, since they facilitate a rapid change from wet to dry, or vice versa.

Material.	Weight of Pint in Ozs.	Specific Gravity.	Dry Content in Ozs.
Ball clay . .	24	2·5	$(24 - 20) \times \frac{2·5}{2·5-1} = \frac{10·0}{1·5} = 6·66$
China clay .	26	2·5	$\frac{6 \times 2·5}{1·5} = 10·00$
Earthenware Slip	28	2·5	$\frac{8 \times 2·5}{1·5} = 13·33$
Stone . .	31	2·5	$\frac{11 \times 2·5}{1·5} = 18·33$
*Flint . .	32	2·6	$\frac{12 \times 2·6}{1·6} = 19·50$
*Flint . .	32	2·5	$\frac{12 \times 2·5}{1·5} = 20·00$
*Flint . .	32	2·4	$\frac{12 \times 2·4}{1·4} = 20·57$
*Flint . .	32	2·3	$\frac{12 \times 2·3}{1·3} = 21·23$
Alkaline Earthenware Slip .	36	2·5	$\frac{16 \times 2·5}{1·5} = 26·66$
Glaze . .	32	4	$\frac{12 \times 4}{3} = 16·00$

On the other hand, however, it is sometimes necessary to have a definite dry weight in a slop pint. Assuming that each slop pint of a glaze stain of sp. gr. 3·6 is to contain

* The specific gravity of flint varies according to the degree of calcination to which it has been subjected; the higher the temperature, the lower the specific gravity. Therefore, with any given slop weight, the lower the degree of calcination, the less the actual dry content.

9 ozs. of dry stain, what must be the slop weight per pint? This is arrived at by using Brongniart's formula (*b*).

$$20 + \left(9 \times \frac{3{\cdot}6 - 1}{3{\cdot}6}\right) = 20 + \left(\frac{9}{1} \times \frac{26}{36}\right)$$
$$= 20 + 6\tfrac{1}{2} = 26\tfrac{1}{2} \text{ ozs.}$$

Again, what must be the slop weight per pint to contain 18 ozs. of dry stain?

$$20 + \left(18 \times \frac{3{\cdot}6 - 1}{3{\cdot}6}\right) = 20 + 13 = 33 \text{ ozs.}$$

From a careful examination of these figures, it follows that, when the specific gravities are alike, the dry content is directly proportional to the excess weight in ounces over 20. The body materials—ball clay, china clay, flint and stone—all have approximately the same specific gravity. This renders the conversion wet-dry, and dry-wet an easy matter when only these four materials are used. (See note on p. 12 *re* China.)

WET RECIPE—DRY RECIPE

Multiply the number of inches by the excess weight in ounces over 20:

(1) Standard Weights.	24 ins.	Ball clay	@ 24 ozs.	24 × 4 =	96	parts by weight	Ball clay	
	24 „	China clay	„ 26 „	24 × 6 =	144	„ „ „	China clay	
	30 „	Flint	„ 32 „	30 × 12 =	360	„ „ „	Flint	
	14 „	Stone	„ 32 „	14 × 12 =	168	„ „ „	Stone	
(2)	10 ins.	Ball clay	„ 23½ „	10 × 3½ =	35	„ „ „	Ball clay	
	12 „	China clay	„ 26 „	12 × 6 =	72	„ „ „	China clay	
	8 „	Flint	„ 31½ „	8 × 11½ =	92	„ „ „	Flint	
	4 „	Stone	„ 31 „	4 × 11 =	44	„ „ „	Stone	

DRY RECIPE—WET RECIPE

To effect the change from dry to wet, the number of parts of each material must be divided by the excess

weight in ounces over 20 in the slop material to be used :

(1) 22 parts by weight Ball clay. Slop weight to be used 24 ozs.
36 „ „ „ China clay. „ „ „ „ „ 26 „
30 „ „ „ Flint. „ „ „ „ „ 32 „
12 „ „ „ Stone. „ „ „ „ „ 32 „

22 ÷ 4 = 5½ ins. Ball clay
36 ÷ 6 = 6 „ China clay
30 ÷ 12 = 2½ „ Flint
12 ÷ 12 = 1 in. Stone

(2) 21 parts by weight Ball clay. Slop weight to be used 23½ ozs.
30 „ „ „ China clay. „ „ „ „ „ 25 „
27 „ „ „ Flint. „ „ „ „ „ 32 „
22 „ „ „ Stone. „ „ „ „ „ 31 „

21 ÷ 3½ = 6 ins. Ball clay
30 ÷ 5 = 6 „ China clay
27 ÷ 12 = 2¼ „ Flint
22 ÷ 11 = 2 „ Stone

The weight per pint of each of the slips which gives the best working conditions, has been found by experience It is such as to allow the ingredients to blend together freely, to pass through the lawns easily, and yet not be so thin as to cause any separation by settling of the different constituents. For specific reasons, some manufacturers occasionally deviate slightly from the standard weights per pint, but it may safely be said that the recognized standard, in general practice, conforms to : ball clay 24 ozs., china clay 26 ozs., flint and stone 32 ozs. per pint respectively.

This being the case, and assuming the specific gravities of the body materials to be the same, the conversions dry to wet, and wet to dry may be simplified.

DRY TO WET

Divide the parts by weight of ball clay, china clay, flint and stone by 1, 1½, 3 and 3 respectively.

10 parts by weight Ball clay ÷ 1 = 10 ins. Ball clay
12 „ „ „ China clay ÷ 1½ = 8 „ China clay
18 „ „ „ Flint ÷ 3 = 6 „ Flint
12 „ „ „ Stone ÷ 3 = 4 „ Stone

WET TO DRY

Take the inches of ball clay as parts by weight dry, $1\frac{1}{2}$ times the inches of china clay, and 3 times the number of inches of flint and stone as parts by weight dry :

10 ins.	Ball clay	× 1	= 10	parts	by	weight	dry
8 „	China clay	× $1\frac{1}{2}$	= 12	„	„	„	„
6 „	Flint	× 3	= 18	„	„	„	„
4 „	Stone	× 3	= 12	„	„	„	„

It must be remembered, however, that these calculations only give theoretical approximations. Allowance must be made for the moisture content of the various materials used. Assuming that in the above example the ball clay contained 25 per cent., the china clay 15 per cent., the flint 13 per cent. and the stone 10 per cent. of moisture, the corrected results would be as follows :

As 75 : 100 : : 10 : x	= 13·33	parts	by	weight	Ball clay
„ 85 : 100 : : 12 : x	= 14·11	„	„	„	China clay
„ 87 : 100 : : 18 : x	= 20·69	„	„	„	Flint
„ 90 : 100 : : 12 : x	= 13·33	„	„	„	Stone

DRY TO WET (corrected)

Moisture as in previous example.

16	parts	by	weight Ball clay
24	„	„	„ China clay
30	„	„	„ Flint
30	„	„	„ Stone

As 100 : 75 : : 16 : x	= 12·0	parts	by	weight	Ball clay
„ 100 : 85 : : 24 : x	= 20·4	„	„	„	China clay
„ 100 : 87 : : 30 : x	= 26·1	„	„	„	Flint
„ 100 : 90 : : 30 : x	= 27·0	„	„	„	Stone

This is then converted into a " wet " recipe according to the rules already given.

BONE CHINA BODY CONVERSIONS

Bone ash has an approximate specific gravity of 3·2, consequently when converting " wet-dry " or " dry-wet " recipes the full formulæ, as indicated on p. 9, will have to be used, and *not* the shortened method given above.

TO CONVERT A WET RECIPE INTO A DRY RECIPE IN EQUIVALENT QUANTITY OR VOLUME

Multiply the area measurement (in square inches) of the blending ark by the specified number of inches of each slop material used. Then, since one peck contains 554·55 cubic inches, divide the results so obtained by 554·55 to find the respective pecks by measure. Assuming that the standard slop weights are adhered to, multiply the number of pecks of ball clay by $6\frac{2}{3}$, of china clay by 10, and of the flint and stone by 20. By simple calculation find the corresponding amounts of each material, allowing for the moisture content and knockings.

Example :—

Body Mixing.	Sp. Gr. of Dry Material.
30 ins. Ball clay at 24 ozs. per pint	2·5
24 „ China clay at 26 ozs. per pint	2·5
13 „ Flint at 32 ozs. per pint	2·5
7 „ Stone at 32 ozs. per pint	2·5

Size of blending ark 6′ × 6′ × 8′ deep.

Assuming that the—

Commercial	Ball clay	contains 25%	moisture + 2·0 %	knockings
„	China clay	„ 13%	„ + 0·3%	„
„	Flint	„ 12%	„	
„	Stone	„ 11%	„	

Ball Clay.— $\frac{72 \times 72 \times 30}{554 \cdot 55} = 280 \cdot 40$ pecks.

$280 \cdot 40 \times 6\frac{2}{3} = 1869 \cdot 30$ lbs.

China Clay.— $\frac{72 \times 72 \times 24}{554 \cdot 55} = 224 \cdot 30$ pecks.

$224 \cdot 30 \times 10 = 2243$ lbs.

Flint.— $\frac{72 \times 72 \times 13}{554 \cdot 55} = 121 \cdot 52$ pecks.

$121 \cdot 52 \times 20 = 2430 \cdot 40$ lbs.

Stone.— $\frac{72 \times 72 \times 7}{554 \cdot 55} = 65 \cdot 43$ pecks.

$65 \cdot 43 \times 20 = 1308 \cdot 60$ lbs.

The theoretical composition is :

Ball clay	1869·30 lbs.
China clay	2243·00 ,,
Flint	2430·40 ,,
Stone	1308·60 ,,

Allowance must now be made for the hygroscopic moisture and knockings in the clays and mill materials.

Ball Clay.—25·0 % moisture.

As 75 : 100 :: 1869·30 : x

$$= \frac{186930}{75} = 2492{\cdot}40 \text{ lbs.}$$

Allow for 2·0 % knockings.

As 98 : 100 :: 2492·40 : x

$$= \frac{249240}{98} = 2543{\cdot}30 \text{ lbs.}$$

China Clay.—13·0 % moisture.

As 87 : 100 :: 2243 : x

$$= \frac{224300}{87} = 2578{\cdot}20 \text{ lbs.}$$

Allow for 0·3 % knockings.

As 99·7 : 100 :: 2578·20 : x

$$= \frac{2578200}{997} = 2586 \text{ lbs.}$$

Flint.—12·0 % moisture.

As 88 : 100 :: 2430·40 : x

$$= \frac{243040}{88} = 2761{\cdot}82 \text{ lbs.}$$

Stone.—11·0 % moisture.

As 89 : 100 :: 1308·60 : x

$$= \frac{130860}{89} = 1470{\cdot}34 \text{ lbs.}$$

The equivalent dry recipe, using commercial materials with moisture and knockings as indicated, is :

Ball clay . . .	2543·30 lbs.
China clay . . .	2586·00 ,,
Flint . . .	2761·82 ,,
Stone . . .	1470·34 ,,

A SLIPMAKER'S CARD

The principle, previously described, for finding the dry contents of slips at a certain weight per pint has been utilized in the compilation of the " slipmaker's card," which gives at a glance the quantities in inches of slips of different slop weights per pint containing the same dry contents. If a slip is above or below the standard weight given in the recipe, the quantity taken must evidently be either diminished or increased. The extent of the alteration required is indicated by the statement that, given the same specific gravity, the dry content of a pint of slip is proportional to the excess weight of the pint over 20 ozs. For instance, suppose slop flint weighed only 31 ozs. instead of 32 ozs. The dry flint present in the quantity of slip used will then only be 11/12 of the amount desired. More slip, therefore, in the proportion of 12 : 11 will have to be taken; hence the rule that the number of inches of slip to be used must be multiplied by the excess of the standard pint-weight over 20 and divided by the *actual* excess weight per pint over 20 ozs., when the slop materials used are not of the exact weight as required by the recipe.

A chart may be compiled which will show what alterations are necessary. Thus, for a works recipe :

30 ins.	Ball clay	@ 24 ozs. to the pint.
24 ,,	China clay	,, 26 ,, ,, ,, ,,
12 ,,	Flint	,, 32 ,, ,, ,, ,,
6 ,,	Stone	,, 32 ,, ,, ,, ,,

Body Recipe.

30 ins. Ball clay at 24 ozs. 12 ins. Flint at 32 ozs.
24 „ China clay at 26 „ 6 „ Stone at 32 „

Ball Clay.

ozs.	22	22¼	22½	22¾	23	23¼	23½	23¾	24 ozs.	24¼	24½	24¾	25	25¼	25½	25¾	26	ozs.
ins.	60	53·3	48	43·6	40	37	34·3	32	30 ins.	28·2	26·6	25·2	24	22·8	21·8	20·9	20	ins.

China Clay.

ozs.	24	24¼	24½	24¾	25	25¼	25½	25¾	26 ozs.	26¼	26½	26¾	27	27¼	27½	27¾	28	ozs.
ins.	36	33·9	32	30·3	28·8	27·4	26·2	25	24 ins.	23	22·1	21·3	20·6	19·9	19·2	18·6	18	ins.

Flint.

ozs.	30	30¼	30½	30¾	31	31¼	31½	31¾	32 ozs.	32¼	32½	32¾	33	33¼	33½	33¾	34	ozs.
ins.	14·4	14	13·7	13·4	13·1	12·8	12·5	12·3	12 ins.	11·8	11·5	11·3	11	10·9	10·7	10·5	10·3	ins.

Stone.

ozs.	30	30⅛	30¼	30⅜	31	31⅛	31¼	31⅜	32 ozs.	32⅛	32¼	32⅜	33	33⅛	33¼	33⅜	34	ozs.
ins.	7·2	7	6·9	6·7	6·5	6·4	6·3	6·1	6 ins.	5·9	5·8	5·6	5·5	5·4	5·3	5·2	5·1	ins.

Example.—If the weights of the slop materials, when mixed, were as follows: Ball clay 23¾, China clay 26½, Flint 32⅛, Stone 31½ ozs., to the pint respectively, the new mixing would become :—

32 ins. Ball clay @ 23¾ ozs.
22 1/16 „ China clay „ 26½ „
11 5/16 „ Flint „ 32⅛ „
6 3/16 „ Stone „ 31½ „

CHAPTER III

REMARKS ON RAW BODY MATERIALS

THERE is a difference of opinion as to the advisability of using several varieties of each raw material in the compounding of a body. Although cases occur when this procedure may not be necessary or desirable, the following remarks are worthy of attention.

Ball Clay.—Rarely is it found that one type of plastic clay is suitable for all purposes. The strong clays are usually poor in colour after firing, whilst the whiter burning kinds are not so plastic. Tensile strength, density, binding power, fineness of grain, the presence of substances likely to interfere with the deflocculating agents used in alkaline casting slips, all require consideration. By the judicious use of several brands of ball clay, these factors are capable of more satisfactory treatment. The same considerations also apply to china clay.

Another feature not to be overlooked is, that where several ball and china clays are blended together, serious losses, owing to one of the materials not being up to standard, are less likely to occur.

Flint.—Bearing in mind the method adopted for the calcination of flint pebbles, it is not surprising to find considerable variations in the product. The upper layers in the kiln are only lightly calcined as compared with those nearer the hearth. During the crushing, grinding, washing-up, and agitation in the stock ark, however, these irregularities are counteracted to a large extent, and the slop flint

sent from the mills represents a reasonable average of the various calcinations and grindings.

Cornish Stone.—As delivered from the mills, Cornish stone is usually a complex mixture containing several varieties ranging from "hard purple" to "dry white." Hard purple is the most satisfactory to use, since it contains the largest proportion of fluxes, but usually there is a difficulty in obtaining it in bulk from the millers at a reasonable price. For bodies in which the colour is of secondary importance, Jersey stone may be used.

Bone Ash.—The many grades of bone ash on the market differ both in physical characteristics and chemical composition. There is no doubt that better results are secured by using several varieties of this material (including a good English brand) in the compounding of a china body.

GRINDING

It is only within recent years that this question has received the attention its importance demands; formerly it was assumed that if a slop material passed a certain lawn, say, 120^s or 140^s, without leaving any appreciable residue, it was correctly ground.

Scientific investigators have shown that further information than that furnished by "lawning" tests is desirable.

Practical application of the knowledge gained in the laboratory has proved the accuracy of the theoretical reasoning, with the result that the leading pottery manufacturers have their materials tested periodically.

Several machines may be used for this purpose. Schöne's elutriator, Schulze's funnels, and modifications thereof, are in daily use. They are giving excellent results.

COMPOUNDING OF BODIES

In the compounding, or building up, of pottery bodies, many complex problems are encountered. It is not only necessary to have complete and accurate knowledge of the behaviour of the raw materials when fired alone in pottery ovens, but also of the more complicated reactions that occur during the firing of mixtures of these materials; *e. g.* if 18 per cent. of bone ash be added to a mixture consisting of equal parts of china clay and stone, the new compound thus formed has a melting point much lower than that of the china clay–stone combination, but if the bone ash content be increased to 50 per cent., the fusion point is again raised.

Before commencing to compound any particular pottery body, careful attention must be given to certain points. Perhaps the most important of these are the commercial and technical requirements, which must be satisfied at a minimum cost. Having settled these points, the question resolves itself into the proper utilization of the raw materials available, or, if satisfactory results cannot be achieved with these, the substitution of others.

The basis of all true pottery bodies is clay. Other ingredients used may be divided into two classes :

(1) Materials added to impart to the body qualities not obtainable from the clays alone.

(2) Materials added to modify some of the characteristics possessed by the clays in too marked a degree.

COMPOUNDING AN EARTHENWARE BODY

Requirements.—The body must be sufficiently plastic to allow of jollying, pressing, throwing and turning; it must be strong enough in the clay state to enable the various articles made from it to be fettled and placed without undue

loss, and, further, it must dry and fire with a minimum of cracking and warping. The colour, texture and density of the body when fired should be satisfactory, and there must be no great difficulty in applying a glaze.

Ball clay, china clay, flint and stone are the usual raw materials employed. In using them, the following points must be kept in mind :

Ball Clay.—Ball clays are very plastic, rather slow in casting and drying, and contract considerably during drying and firing. When fired in an earthenware biscuit oven, they become very hard and dense, the colour varying from cream to grey.

The amount introduced into a body should be sufficient to impart the required plasticity for making purposes, strength during fettling and placing, and the requisite density after firing. If used in excess, difficulties may arise in filter-pressing, owing to the fine grain of the clay. " Wreathing " and similar faults during the making, and losses in drying and firing, due to excessive contraction, would also occur. The fired colour would be poor, and the " dipping " rendered difficult on account of the low porosity.

China Clay.—This is only slightly plastic, and casts quickly. Its low tensile strength tends to give excessive losses in the clay state, but, on the other hand, its high porosity and low contraction enable it to be dried and fired with a minimum of cracking and warping, and also to withstand sudden variations of temperature. In the biscuit state it is white in colour and rather porous. If used in excess, it predisposes the body to crazing.

The addition of 50 per cent. of china clay to ball clay will counteract the excessive plasticity of the latter, but not to such an extent as to render the making operations difficult. The smaller contraction and increased porosity, as compared with ball clay alone, facilitate drying and

firing operations. The fired colour is also improved. The slight tendency of this "clayey" mixture to craze when glazed, is overcome by the addition of flint.

Flint.—Flint is a non-plastic material, with an extremely low drying and firing contraction. High porosity and very good colour are characteristics of fired flint. When added to a mixture containing equal parts of ball and china clay in the proportion of 30 parts to 50 of the clay mixture, it reduces the plasticity and tensile strength, but still leaves a good margin of safety. The contraction is lowered, while the porosity is increased, thus facilitating drying and firing. Flint also improves the fired colour. As already stated, it prevents crazing, but if used in excess its low tensile strength is likely to increase losses in the clay state, due to strained ware. Highly "flinted" bodies are liable to dunt, and also to peel, when glazed. A mixture of 25 parts ball clay, 25 parts china clay, and 30 parts of flint is lacking in density and "ring." This is remedied by the addition of, say, 20 parts of Cornish stone.

Cornish Stone.—When fired in an earthenware biscuit oven, this material softens without actually melting, and it is an extremely useful flux on account of its wide vitrification range. Cornish stone is only feebly plastic, and when added to the clay–flint mixture it decreases the tensile strength and increases the porosity previous to firing.

A body having the following composition: ball clay 25, china clay 25, flint 30, stone 20 parts by weight respectively, when properly fired, increases in density slowly and evenly, has a reasonably good colour, and is capable of being glazed successfully.

Circumstances may arise which render it necessary, in the compounding of an earthenware body, to use materials other than those indicated, *e. g.* felspar in place of Cornish stone. Should this be the case, it must be remembered

that felspar contains more fluxes, but less alumina and silica than Cornish stone. A smaller amount of felspar will therefore be required to furnish the equivalent quantity of fluxes, the deficiency in alumina and silica being made good by the addition of china clay and flint.

In all cases, the blending together of the various raw materials to give satisfactory bodies is largely a matter of compromise. At the best, pottery bodies can only be regarded as well-balanced mechanical mixtures.

CHAPTER IV

BODIES

CHINA BODIES

BALL clay is often used in bone china bodies. When this is the case a good brand should be selected, and the quantity kept as low as possible consistent with economical working. The majority of bone china bodies are apportioned by the dry method of mixing, either by weight or volume; consequently, special attention should be paid to the moisture content of the raw materials (see pp. 1-2), since slight irregularities are sufficient to upset an otherwise well-balanced mixture.

1 CHINA BODY.

440 lbs.	Bone
260 „	Stone
260 „	China Clay
25 „	Flint

2 FELSPATHIC CHINA BODY.

140 lbs.	Bone
80 „	Swedish Felspar
100 „	China Clay
10 „	Flint

3 CHINA BODY.

450 lbs.	Bone
230 „	Stone
220 „	China Clay
30 „	Flint

4 FENTON CHINA BODY.

290 lbs. Bone
170 ,, Stone
150 ,, China Clay
20 ,, Flint

5 CHINA BODY.

165 lbs. Bone
160 ,, Stone
70 ,, China Clay
20 ,, Ball Clay
25 ,, Flint

6 CHINA BODY.

580 lbs. Bone
350 ,, Stone
310 ,, China Clay

7 CHINA BODY.

215 lbs. Bone
120 ,, Stone
100 ,, China Clay
18 ,, Ball Clay

8 COMMON CHINA BODY.

200 lbs. Bone
180 ,, Stone
75 ,, China Clay
80 ,, Ball Clay
30 ,, Flint

9 MEDIUM CHINA BODY.

460 lbs. Bone
280 ,, Stone
260 ,, China Clay
50 ,, Semi-Porcelain Shavings

10 CHINA BODY.

645 lbs. Bone
425 „ Stone
390 „ China Clay

11 CHINA BODY.

200 lbs. Bone
120 „ Hard Purple Stone
85 „ China Clay
25 „ Ball Clay

12 SPECIAL CHINA BODY.

39 lbs. Pure Phosphate Cos. Bone
35 „ Stone
24 „ China Clay
2 „ Ball Clay

13 LONGPORT CHINA BODY.

225 lbs. Bone
85 „ Hard Purple Stone
150 „ China Clay
15 „ Flint

14 MASON'S CHINA BODY.

285 lbs. Bone
165 „ Stone
200 „ China Clay
30 „ Flint

15 DESSERT CHINA BODY.

140 lbs. Bone
90 „ Stone
77 „ China Clay
10 „ Ball Clay

16 ALCOCK'S FIGURE BODY.

215 lbs. Bone
155 „ Stone
120 „ China Clay

17 CHINA BODY.

235 lbs. Bone
135 „ Stone
110 „ China Clay
20 „ Ball Clay

18 SPECIAL CHINA BODY.

300 lbs. Bone
190 „ Stone
185 „ China Clay
15 „ Ball Clay
35 „ China Pitchers

19 FELSPAR CHINA BODY.

46 lbs. Bone
15 „ Felspar
31 „ China Clay
8 „ Flint

20 FELSPAR CHINA BODY.

50 lbs. Bone
14 „ Felspar
28 „ China Clay
8 „ Flint

21 SPODE'S CHINA BODY.

120 lbs. Bone
80 „ Flint
ground together

Add

80 lbs. Stone
40 „ China Clay

22 **NANTGARW CHINA BODY (Soft Paste).**

Fritt—210 lbs. Lynn Sand
30 „ Pearl Ash
Body—150 lbs. Fritt
220 „ Bone
65 „ China Clay

23 **FRENCH CHINA BODY.**

Fritt—250 lbs. Lynn Sand
20 „ Pearl Ash
Body—25 lbs. Fritt
120 „ Bone
100 „ Stone
100 „ China Clay
10 „ Ball Clay

24 **SÈVRES PORCELAIN BODY (Soft Paste).**

Fritt—90 lbs. Sand
35 „ Nitre
10 „ Salt
6 „ Soda Ash
6 „ Alum (Potass.)
5 „ Gypsum
Body—85 lbs. Fritt
20 „ Chalk
10 „ China Clay

Aged well before use.

25 **OLD WORCESTER CHINA BODY.**

90 lbs. Bone
140 „ Stone
90 „ China Clay
15 „ Ball Clay

26 **LIME CHINA BODY.**

44 lbs. Bone
33 „ Stone
45 „ China Clay
12 „ Whiting

27 **APATITE BODY.**

46 lbs. Apatite (Must be well ground).
27 „ Stone
24 „ China Clay
3 „ Ball Clay

28 **PURPLE CHINA BODY.**

200 lbs. Body No. 6. Page 24
1 lb. Oxide of Cobalt (Prepared)

Grind on Pan.

29 **LIGHT GREEN CHINA BODY.**

180 lbs. Body No. 6. Page 24
4 ozs. Oxide of Chrome

Grind on Pan.

30 **BLUISH-GREEN CHINA BODY.**

180 lbs. Body No. 6. Page 24
4 ozs. Oxide of Cobalt (Prepared)
2 ozs. Oxide of Chrome

Grind on Pan.

ALKALINE CASTING SLIPS.

1 150 lbs. China Body No. 6 (Direct from press).
17 pints Water
5¼ ozs. Silicate of Soda 80° T.

2 145 lbs. China Body No. 6 (Direct from press).
12 pints Ball Clay Slip @ 24 ozs.
9 pints Water
4 ozs. Silicate of Soda 80° T.
1½ ozs. Soda Ash

3 140 lbs. China Body No. 6 (Direct from press).
8 lbs. Best "Semi-Porcelain" Scraps
17 pints Water
5¼ ozs. Silicate of Soda 80° T.

PARIAN BODIES

The commercial glasses on the market vary considerably in their alkali and lead contents. For Parian mixtures, containing glass, it is therefore necessary to use one of known and constant ultimate composition. In the production of good Parian bodies, the careful grinding both of the materials and the body itself is very important. The vitrification range is so narrow, that a slightly over-ground body is liable to squat under normal firing treatment, while, on the other hand, a short-ground Parian body, fired in the same way, would be lacking in translucency and density.

1 STANDARD PARIAN.

67 lbs. Felspar
33 ,, China Clay

2 PARIAN.

19 lbs. Stone
23 ,, Felspar
43 ,, China Clay
3 ,, Ball Clay
12 ,, Flint Glass

3 COMMON PARIAN.

38 lbs. Stone
35 ,, Felspar
20 ,, China Clay
7 ,, Ball Clay

4 DOLL'S HEAD PARIAN.

20 lbs. Stone
31½ ,, Felspar
37 ,, China Clay
2½ ,, Ball Clay
9 ,, Flint Glass

5 PARIAN FRITT.

56½ lbs. Lynn Sand
24½ ,, Felspar
11 ,, Stone
8 ,, Pearl Ash

Fritt in Hard Parian Biscuit.

6 BODY.

15 lbs. Fritt No. 5
40 ,, Felspar
40 ,, China Clay
5 ,, Flint Glass

7 STATUETTE BODY.

24 lbs. Fritt No. 5
40 ,, Felspar
36 ,, China Clay

8 PARIAN FOR SMALL ARTICLES.

65 lbs. Felspar
35 ,, China Clay
5 ,, Flint

9 **FLESH-TINTED DOLL BODY.**

100 lbs. Parian Body No. 4
1½ ,, Japanese Red

Special care in Grinding.

10 **PARIAN FOR DRAPERY.**

27 lbs. Stone
40 ,, Felspar
30 ,, China Clay
3 ,, Ball Clay

11 **SPECIAL PARIAN.**

20 lbs. Stone
23 ,, Felspar
43 ,, China Clay
2 ,, Ball Clay
6 ,, Flint Glass
6 ,, Barium Carbonate

12 **PARIAN FOR CELLULOID VARNISHES.**

27 lbs. Stone
37 ,, Felspar
7 ,, Whiting
26 ,, China Clay
3 ,, Ball Clay

13 **DOLL'S HEAD PARIAN (Hard).**

50 lbs. Felspar
3 ,, Whiting
26 ,, China Clay
21 ,, Quartz

IRONSTONE, GRANITE, SEMI-PORCELAIN, EARTHENWARE, CREAM-COLOUR AND VITREOUS BODIES

These are interchangeable terms applied to a range of bodies more or less vitrified. Certain types, such as insulator and mortar bodies, have little or no porosity when correctly fired, while others, *e. g.* wall tiles, may have a porosity of 25–30 per cent. A gradually increasing firing temperature, or even the same maximum heat maintained for a longer period, will alter the porosity of the same mixture, so that, in all cases, the final product is dependent upon the firing treatment. Unless otherwise stated, the standard slop weights—Ball clay 24, China clay 26, Flint and Stone 32 ozs. per pint respectively—are adhered to where the body recipes are given in inches.

With regard to the advisability of using several varieties of each of the body materials, see p. 17.

Body stains are dealt with on p. 55.

1 EARTHENWARE BODY FOR BISCUIT AERO WORK.

38	ins.	Ball Clay
16¼	„	China Clay
16	„	Flint
7¼	„	Stone

2 LONGPORT MORTAR BODY.

120	lbs.	Ball Clay
120	„	China Clay
20	„	Flint
240	„	Stone
8	„	Flint Glass

3 **MORTAR BODY.**

215 lbs. Blue Ball Clay . . .
70 „ China Clay
75 „ Jersey Stone . . .

4 **MORTAR BODY.**

30 lbs. Ball Clay
25 „ China Clay
45 „ Hard Purple Stone . . .

5 **MORTAR BODY.**

44 lbs. Blue Ball Clay . . .
96 „ Jersey Stone . . .

6 **HANLEY MORTAR BODY** (Suitable for Glazing).

50 lbs. Ball Clay
20 „ Flint
30 „ Stone

7 **IRONSTONE BODY.**

170 lbs. Blue Ball Clay . . .
230 „ China Clay
90 „ Flint
300 „ Stone

8 **IRONSTONE BODY.**

31 ins. Blue Ball Clay . . .
18 „ China Clay
13 „ Flint
13 „ Stone

9 IRONSTONE BODY.

19¾ ins.	Blue Ball Clay	. . .
11¼ „	China Clay	
8½ „	Flint	
8½ „	Stone	

10 PRINTED BODY.

14½ ins.	Black Ball Clay	. . .
10 „	China Clay @ 25½ ozs.	. .
7 „	Flint	
2 „	Stone	

11 PRINTED BODY.

28 ins.	Ball Clay	
19 „	China Clay	
10 „	Flint	
6¾ „	Stone	

12 BEST PRINTED BODY.

21 ins.	Ball Clay	
14 „	China Clay	
8 „	Flint	
5 „	Stone	

13 COMMON PRINTED BODY.

14 ins.	Ball Clay	
10 „	China Clay	
6 „	Flint	
4 „	Stone	

14 GRANITE BODY.

16 lbs.	Blue Ball Clay	. . .
30 „	China Clay	
6 „	Flint	
35 „	Purple Stone	. . .

15 STONE BODY.

14 lbs. Ball Clay
10 „ China Clay
6 „ Flint
18 „ Stone

16 STONE BODY.

21 lbs. Blue Ball Clay . . .
14 „ China Clay
6 „ Flint
15 „ Purple Stone . . .

17 VITREOUS BODY.

42 ins. Ball Clay
12 „ China Clay
4 „ Flint
22 „ Stone

18 COMMON VITREOUS BODY.

30 lbs. Ball Clay
22 „ China Clay
18 „ Flint
30 „ Jersey Stone

19 VITREOUS WHITE TILE BODY.

27 ins. Ball Clay
13 „ China Clay
5 „ Flint
16 „ Stone

20 IVORY VITREOUS BODY.

15 ins. Ivory Ball Clay . . .
3½ „ China Clay
1 in. Flint
9 ins. Stone

21 VITREOUS HOTEL WARE BODY.

16 lbs. Ball Clay
28 „ China Clay
22 „ Flint
34 „ Swedish Felspar

22 VITREOUS MALT KILN TILE BODY.

10 ins. Ball Clay
12 „ China Clay
4½ „ Flint
11 „ Purple Stone

23 INSULATOR BODY.

45 lbs. Blue Ball Clay
35 „ Flint
20 „ Jersey Stone
3 „ Oxide of Zinc

24 MAYER'S SANITARY BODY.

16¼ ins. Ball Clay
7½ „ China Clay
6 „ Flint
2¼ „ Stone

25 SANITARY BODY.

16½ ins. Ball Clay
5 „ China Clay
3½ „ Flint
5 „ Stone

26 SEMI-PORCELAIN BODY.

11 ins. Ball Clay
10 „ China Clay @ 25½ ozs.
5 „ Flint
3 „ Stone

27 **IVORY DINNER WARE BODY.**

31 lbs. Blue Ball Clay . . .
25 ,, China Clay
29 ,, Flint
15 ,, Stone

28 **SEMI-PORCELAIN BODY.**

14 ins. Ball Clay
10½ ,, China Clay
8½ ,, Flint
4½ ,, Stone

29 **SEMI-PORCELAIN BODY.**

14½ ins. Ball Clay
11¾ ,, China Clay
8½ ,, Flint
4 ,, Stone

30 **IVORY EARTHENWARE BODY.**

23 lbs. Ball Clay
10 ,, China Clay
18 ,, Flint
15 ,, Stone

31 **COMMON IVORY BODY.**

32 ins. Ivory Ball Clay . . .
6 ,, China Clay
4 ,, Flint
1¼ ,, Buff Stone

32 **C. C. BODY.**

30 ins. Ball Clay @ 23½ ozs. . .
14 ,, China Clay
8½ ,, Flint
4¼ ,, Stone

33 **C. C. BODY.**

24½	ins.	Ivory Ball Clay
13½	,,	China Clay
7	,,	Flint
3	,,	Stone

34 **WHITE WALL-TILE BODY.**

15	lbs.	Black Ball Clay
17	,,	China Clay
27	,,	Flint
8	,,	Stone

35 **WHITE WALL-TILE BODY.**

11	ins.	Black Ball Clay
7	,,	China Clay
7	,,	Flint
3	,,	Stone

36 **IVORY WALL-TILE BODY.**

22½	ins.	Ball Clay
11½	,,	China Clay
8½	,,	Flint
3½	,,	Stone

37 **EARTHENWARE LIME BODY.**

28	lbs.	Ball Clay
16	,,	China Clay
30	,,	Flint
16	,,	Stone
4	,,	Whiting

38 EARTHENWARE LIME BODY.

25 lbs. Ball Clay
25 „ China Clay
35 „ Flint
10 „ Stone
5 „ Whiting

39 CHEAP CONTINENTAL EARTHENWARE BODY.

22 lbs. Ball Clay
20 „ China Clay
30 „ Sand
4 „ Whiting

(Sand must be ground very finely.)

40 DOLOMITE BODY.

375 lbs. Ball Clay
140 „ China Clay
180 „ Sand
475 „ Dolomite

41 DOLOMITE BODY.

250 lbs. Ball Clay
200 „ China Clay
250 „ Flint
250 „ Felspar
50 „ Dolomite

42 ALKALINE CASTING SLIP (Earthenware).

1 ton Earthenware Body (direct from press)
2¾ lbs. Sodium Silicate 80° T.
2¾ lbs. Soda Ash
17 galls. Water

43 **ALKALINE CASTING SLIP (Earthenware).**

1 ton Earthenware Body (pugged)
3¼ lbs. Sodium Silicate 80° T.
2½ lbs. Soda Ash
17 galls. Water

FLOORING TILE BODIES

1 **BUFF.**

13½ cwts. Cane Marl
3¼ „ Stone
3¼ „ Ball Clay

2 **BUFF.**

1 ton Fireclay
½ cwt. Red Clay
28 lbs. Flint.

3 **SALMON.**

51 ins. Cane Marl @ 26 ozs.
9½ „ Red Clay @ 24 ozs.
9¼ „ Flint @ 32 ozs.

4 **RED.**

19½ cwts. Red Clay
½ cwt. China Clay

5 **RED.**

19¾ cwts. Red Clay
¼ cwt. Flint

6 **CHOCOLATE.**

1 ton Red Clay
20 lbs. Bull Dog
10 „ Oxide of Manganese

7 **CHOCOLATE.**

1 ton Red Clay
50 lbs. Crude Manganese . . .

8 **BLACK.**

1 ton Red Clay
¾ cwt. Bull Dog
¾ „ Wad

9 **DRAB.**

750 lbs. Fireclay
750 „ Blue Ball Clay . . .
750 „ China Clay

10 **WHITE VITREOUS.**

5 lbs. Ball Clay
35 „ China Clay
50 „ Felspar
6 „ Flint
4 „ Bone Ash

11 **WHITE VITREOUS.**

5 lbs. Ball Clay
35 „ China Clay
8 „ Flint
47 „ Felspar
5 „ Oxide of Zinc . . .

12 **PINK VITREOUS.**

36 lbs. Blue Ball Clay . . .
44½ „ Stone
15 „ Whiting
4½ „ Oxide of Tin
4 „ U.G. Pink

13 BRIGHT GREEN VITREOUS.

5 lbs. Ball Clay
35 „ China Clay
52 „ Felspar
8 „ Flint
5 „ U.G. Victoria Green

14 BLUE VITREOUS.

35 lbs. Ball Clay
10 „ China Clay
55 „ Stone
3 „ Oxide of Cobalt (Prep.)

15 WHITE VITREOUS.

20 lbs. Ball Clay
20 „ China Clay
25 „ Flint
35 „ Felspar

JASPER BODIES

1 WHITE.

30 lbs. Ball Clay
60 „ Barium Sulphate
3 „ Barium Carbonate
7 „ Flint

2 WHITE.

28 lbs. Ball Clay
16 „ China Clay
34 „ Hard Purple Stone
22 „ Barium Sulphate

3 WHITE FIGURE.

38 lbs. Ball Clay
22 „ Bone Ash
10 „ Flint
30 „ Barium Carbonate

4 BLUE.

20 lbs. Blue Ball Clay
16 „ China Clay
22½ „ Hard Purple Stone
31½ „ Barium Sulphate
6½ „ Flint Glass
3½ „ Oxide of Cobalt (Black)

5 BLUE.

15 lbs. Blue Ball Clay
20 „ China Clay
20 „ Hard Purple Stone
36 „ Barium Sulphate
6 „ Flint Glass
3 „ Oxide of Cobalt (Black)

6 BLUE.

17 lbs. Blue Ball Clay
17 „ China Clay
33 „ Hard Purple Stone
27 „ Barium Sulphate
4 „ Flint Glass
2 „ Oxide of Cobalt (Black)

7 GREEN.

100 lbs.	Body No. 1	
8 ,,	Green Stain	
Stain.—20 ,,	Fluorspar	
30 ,,	Flint	Fritt in Glost Oven.
50 ,,	Borax	
20 ,,	Soda Ash	
30 ,,	Oxide of Chromium	

8 LILAC.

100 lbs.	Body No. 1
1 lb.	Oxide of Cobalt (Black)
1 oz.	U.G. Pink

All coloured jaspers must be ground well on the pan before use.

ANTIQUE TILE BODIES

1	65 lbs.	Fireclay
	35 ,,	Ground Pitchers (20's Mesh)
2	65 lbs.	Fireclay
	35 ,,	Grog (20's Mesh)
3	60 lbs.	Red Clay
	40 ,,	Grog (20's Mesh)
4	60 lbs.	Waste Dust (from Grinding Room)
	20 ,,	Grog (20's Mesh)
	20 ,,	Ground Pitchers (20's Mesh)

CRAQUELLE ENGOBE FOR ABOVE BODIES.

90 lbs.	China Clay
10 ,,	Ball Clay

POROUS BODIES

1 BATTERY JAR.

26 lbs. Ball Clay
38 „ China Clay
36 „ Flint

2 BATTERY JAR.

30 lbs. Ball Clay
25 „ China Clay
15 „ Fireclay
30 „ Ground Pitchers . . .

3 WATER COOLER.

87 lbs. Fireclay
13 „ Flint

4 WATER COOLER.

80 lbs. Red Clay
20 „ China Clay

ROCKINGHAM TEAPOT BODIES

1 550 lbs. Red Clay
100 „ Cane Clay

2 250 lbs. Red Clay
150 „ China Clay
50 „ Flint

3 400 lbs. Red Clay
150 „ Buff Marl

PORCELAINIC BODIES

1 PORCELAIN { Cone 9. / Bar No. 28.

5 lbs.	Ball Clay	
40 ,,	China Clay	
15 ,,	Flint	
30 ,,	Felspar	
10 ,,	Purple Stone	

2 PORCELAIN { Cone 12. / Bar No. 31.

3 lbs.	Ball Clay	
55 ,,	China Clay	
20 ,,	Flint	
22 ,,	Felspar	

3 PORCELAIN { Cone 15. / Bar No. 33.

85 lbs.	China Clay	
15 ,,	Felspar	

4 CHEMICAL PORCELAIN { Cone 15. / Bar No. 33.

2 lbs.	Ball Clay	
21 ,,	China Clay	
20 ,,	China Clay (Calcined)	. .
10 ,,	Flint	
25 ,,	Felspar	
22 ,,	Alumina Hydrate	. . .

5 **DENTAL PORCELAIN** {Cone 9. Bar No. 28.

2 lbs.	Ball Clay	
8 „	China Clay	
82 „	Hard Purple Stone	. . .
5 „	Whiting	
3 „	Bone Ash	

6 **MANTLE RING.**

10 lbs.	Ball Clay	
68 „	China Clay	
17 „	China Clay (Calcined)	. .
5 „	Talc	

7 **SPARKING PLUG** {Cone 9. Bar No. 28.

2 lbs.	Ball Clay	
49 „	China Clay	
33 „	Felspar	
5 „	Flint	
11 „	Steatite	

8 **SPARKING PLUG.**

65 lbs.	China Clay	
25 „	Magnesium Carbonate	. .
6 „	Flint	
4 „	Boracic Acid	

Calcine to Cone 9. Bar No. 28.

BODY {Cone 9. Bar No. 28.

50 lbs.	Calcine	
10 „	Ball Clay	
40 „	China Clay	

9 SPARKING PLUG { Cone 12. Bar No. 31.

33 lbs. Ball Clay
55 ,, China Clay
12 ,, Sintered Magnesite . . .

ENAMELLED FIRECLAY { Cone 8. Bar No. 27.

1 BODY.

600 lbs. Fireclay
50 ,, Ball Clay
350 ,, Fine Grog (clean Firebricks ground)

2 BODY.

700 lbs. Fireclay
300 ,, Fine Grog (clean Firebricks ground)

1 ENGOBE.

15 lbs. Ball Clay
50 ,, China Clay
15 ,, Flint
17 ,, Felspar
3 ,, Plaster

2 ENGOBE.

10 lbs. Ball Clay
45 ,, China Clay
20 ,, Flint
8 ,, Felspar
12 ,, Stone
5 ,, Whiting

3 ENGOBE.

10 lbs. Ball Clay
40 „ China Clay
20 „ Flint
20 „ Felspar
10 „ Stone

MISCELLANEOUS COLOURED BODIES

1 LILAC.

27½ lbs. Ball Clay
35 „ China Clay
27½ „ Flint
9½ „ Stone
½ lb. Oxide of Cobalt (Prep.)

2 CANARY.

52 ins. Little-Row Marl @ 24 ozs.
12½ „ China Clay @ 26 ozs.
2 „ Purple Stone @ 32 ozs.

3 YELLOW.

50 lbs. Cane Marl
25 „ China Clay
12½ „ Flint
12½ „ Purple Stone

4 BROWN.

83 lbs. Red Clay
13 „ China Clay
2 „ Flint
2 „ Oxide of Manganese

4

5 **CANE.**

31½ ins. Cane Marl @ 26 ozs.
13½ „ Ball Clay @ 24 ozs.
5 „ Flint @ 32 ozs.

6 **CANE.**

67 lbs. Strong Cane Marl
33 „ Purple Stone

7 **DRAB.**

70 lbs. Blue Ball Clay
27 „ Flint
3 „ Oxide of Nickel

8 **EGYPTIAN BLACK.**

40 lbs. Blue Ball Clay
32 „ Red Ochre
16 „ Ironstone
12 „ Oxide of Manganese

9 **EGYPTIAN BLACK.**

53 lbs. Blue Ball Clay
26 „ Red Ochre
10 „ Iron Scales
11 „ Oxide of Manganese

10 **SPECIAL BLACK.**

74 lbs. Blue Ball Clay
5 „ Purple Stone
8 „ Oxide of Nickel
13 „ Oxide of Manganese

11 **DRY BLACK.**

50 lbs. Blue Ball Clay
24 „ Red Clay
12 „ Oxide of Manganese
14 „ Oxide of Iron (Purple)

12 **BLACK.**

50 lbs. Red Clay
40 „ Ironstone
8 „ Wad
2 „ Chromate of Iron

13 **BLACK.**

50 lbs. Red Clay
40 „ Bull Dog
10 „ Turkey Umber

14 **ORANGE.**

50 lbs. Fireclay
25 „ China Clay
12½ „ Flint
12½ „ Stone

15 **RED MAJOLICA.**

30 ins. Red Clay @ 26 ozs.
4 „ China Clay @ 25½ ozs.
3½ „ Flint @ 32 ozs.

16 **TURQUOISE.**

25 galls. Ball Clay Slip @ 24 ozs.
1½ lbs. Stain No. 18

17 TURQUOISE.

25 galls. Earthenware Slip @ 27½ ozs.
1¾ lbs. Stain No. 18 . . .

18 TURQUOISE STAIN.

10 lbs. Barium Sulphate . . .
13 ,, Oxide of Zinc . . .
2 ,, Oxide of Cobalt . . .

Calcine in Earthenware Bis. Oven.

MISCELLANEOUS BODIES

1 STILT BODY.

78 lbs. Blue Ball Clay . . .
10 ,, China Clay
12 ,, Flint

2 STILT BODY.

75 lbs. Blue Ball Clay . . .
5 ,, China Clay
15 ,, Flint
5 ,, Whiting

3 CULINARY FIREPROOF.

85 lbs. China Clay
15 ,, Ball Clay

4 COMMON FIREPROOF.

50 lbs. Fireclay
50 ,, China Clay

5 FIRING RINGS AND BITS.

12 lbs. Ball Clay
88 ,, China Clay

6 WHITE TUBE LINING FOR WALL TILES.

5 lbs. Felspar
1½ „ Flint
2½ „ Vitreous White Tile Pitchers .
½ lb. Ball Clay

7 BLACK TUBE LINING FOR WALL TILES.

2 lbs. Felspar
1½ „ Flint
3 „ Parian Pitchers . . .
½ lb. Blue Majolica Glaze . .
½ „ Chromate of Iron . . .
½ „ Ball Clay

8 BISCUIT STOPPING.

Equal parts of ground pitchers and stone are mixed together dry, and then sufficient glaze is added to render the mixture workable.

9 RUBBING STONES.

3 pints Ball Slip
2 „ Stone
2¼ „ Glaze

Mix thoroughly, and add sufficient sharp sand to enable the mass to be worked into pieces of the requisite size and shape.

Fire in Biscuit Oven.

10 ADHESIVE MIXTURE.

For boxing cups, slop-basins, etc., ready for biscuit firing.

10 parts Irish Moss
6 „ Linseed
1½ „ Sugar
1 part Borax

Boiled with water.

EARTHENWARE COLOURED DIPS

Dip stains should be wet ground very finely and always kept in a slop condition. By grinding the body and stain together, even for a short time, a more uniform tone of colour is obtained, and the danger of specking reduced to a minimum.

The contraction of the dip may have to be adjusted to fit the body to which it is applied; if necessary or desired the contraction can be increased or decreased by the addition of clay or flint respectively.

In addition to the stains given below, "Underglaze" colours and natural ochreous materials—*e. g.* Thiviers Earth—may also be used with satisfactory results.

In the following recipes the earthenware slip is at 27½ ozs. to the pint.

1 LIGHT BLUE.

2 gallons Slip
½ pint Slop Cobalt @ 30 ozs. per pint .

2 DARK BLUE.

2 gallons Slip
1¼ pints Slop Cobalt @ 30 ozs. per pint

3 MATT BLUE.

2 gallons Slip
1½ pints Slop U.G. Matt Blue @ 28 ozs. per pint

4 BLACK.

2 gallons Slip
2 pints Slop U.G. Black @ 29 ozs. per pint

5 **GREEN.**

2 gallons Slip
1¾ pints Slop Chrome @ 31 ozs. per pint

6 **GREEN.**

2 gallons Slip
1½ pints Slop Nickel @ 31 ozs. per pint
¼ pint Slop Cobalt @ 30 ozs. per pint

7 **BLUE GREEN.**

2 gallons Slip
1¾ pints Slop Chrome @ 31 ozs. per pint
¼ pint Slop Cobalt @ 30 ozs. per pint

8 **PINK.**

2 gallons Slip
2½ pints Slop U.G. Pink @ 32 ozs. per pint
2 pints Slop Whiting @ 32 ozs. per pint
2 pints Slop Stone @ 32 ozs. per pint.

9 **PALE PINK.**

2 gallons Slip
1 gallon Red Clay Slip @ 26 ozs. per pint

BODY STAINS

When a white, or bluish-white colour after firing is essential, the slight ivory tinge imparted by the "clayey" materials is masked by the addition of a minute proportion

of cobalt blue stain. An insoluble stain may be prepared by mixing together black or prepared cobalt oxide, and fluxes, such as stone, flint glass, parian pitchers, zinc oxide, etc., and then fritting the mixture in an earthenware biscuit oven. The complex, insoluble cobalt silicate which is formed should be very finely ground in water, and passed through a fine silk lawn. A predetermined volume, at a standard weight per pint, is added to each mixing. A simpler method is to use a soluble cobalt salt (either chloride, nitrate or sulphate), as these merely require dissolving in water before use. This type of decolorizer eliminates the necessity of fritting and grinding, and reduces to a minimum the risk of blue specking in the body. 3·87 lbs. of nitrate, 3·16 lbs. of chloride, or 3·73 lbs. of sulphate, are equivalent in staining power to 1 lb. of prepared oxide of cobalt. When calculations are made with a view to substituting a soluble for an insoluble stain, or vice versa, due allowance must be made for the accompanying diluents present in the older types of stains. It is inadvisable to state the quantity to be added to each mixing for the following reasons:

The capacity of the mixing arks, quality of materials used, the sliphouse equipment particularly as regards the removal of magnetic iron compounds, and firing temperatures vary over a wide range at various factories, hence it is obvious that the quantity of stain necessary for a given recipe will have to be determined experimentally.

STAINS.

1	3 lbs. Oxide of Cobalt . . .	}	Fritt in E'ware Bis.
	2 „ Flint Glass		
2	7 lbs. Oxide of Cobalt . . .	}	Fritt in E'ware Bis.
	6 „ Parian Pitchers . . .		
	6 „ Stone		

3	8 lbs.	Oxide of Cobalt . . .	Fritt in E'ware Bis.
	6½ ,,	Flint	
	2½ ,,	Red Lead	
4	6 lbs.	Oxide of Cobalt . . .	Fritt in China Bis.
	2 ,,	Flint	
	8 ,,	Stone	
5	10 lbs.	Oxide of Cobalt . . .	Fritt in China Bis.
	5 ,,	Flint	
	5 ,,	Stone	
6	8 lbs.	Oxide of Cobalt . . .	Fritt in China Bis.
	8 ,,	China Clay	
7	8 lbs.	Oxide of Cobalt . . .	Fritt in China Bis.
	4 ,,	Stone	

CHAPTER V

SAGGARS

In general, saggars are made from a mixture of clay and grog. Several types of clays are used, the more important being—first and second grade fireclays, china clay and ball clay.

Plastic fireclays, with a chemical composition ranging from 50 to 65 per cent. SiO_2, 22 to 38 per cent. Al_2O_3, 2 to 5 per cent. Fe_2O_3, 1 to 3·5 per cent. alkalies, are probably the best for saggar making. By the addition of a variable proportion of hard-fired and correctly graded grog to a weathered clay of this type, it is possible to get a mixture from which saggars can be made economically, and which with ordinary care will render reasonably good service. Materials other than those already mentioned have been used in saggar mixtures; they include fused quartz, carborundum, asbestos, sewage sludge, and electrically purified fireclays. At present their use is only in the experimental stage; they are, therefore, not included in any of the saggar mixtures given. It is difficult to specify a satisfactory saggar mixture without precise information as to (1) the conditions the saggars are intended to fulfil; (2) the physical properties and the chemical composition of the raw materials. Several of the following mixtures, however, are being employed successfully at large factories. It will be noticed that all the grog is graded; practical experience proves this procedure to be commercially sound. Though mixtures for the saggar bottoms usually contain more grog than those used for the sides, it is possible to employ one mixture for

both, provided that the material from which the bottoms are made is kept stiffer than that used for the sides.

Great attention should be paid to the mixing of the clay and grog so as to get a uniform mixture. Care is also necessary in drying the saggars if good results are to be obtained.

GRADING DATA.

Dust passes a 16s.
No. 1, too coarse to pass a 16s, passes an 8s.
No. 2, ,, ,, an 8s, ,, a 4s.
No. 3, ,, ,, a 4s, ,, a $\frac{3}{8}$s.

SAGGAR MIXTURES.

	(1)	(2)	(3)	(4)	(5)
Fireclay . .	50	50	55	55	60
Dust Grog . .	5	5	—	—	—
No. 1 ,, . .	10	10	10	10	5
No. 2 ,, . .	15	10	15	10	5
No. 3 ,, . .	20	25	20	25	30

	(6)	(7)	(8)	(9)
Fireclay . . .	35	25	15	—
Ball Clay . . .	15	15	15	15
China Clay . .	—	10	20	35
Dust Grog . .	—	—	5	5
No. 1 ,, . .	10	10	15	15
No. 2 ,, . . .	15	20	15	20
No. 3 ,, . . .	25	20	15	10

	(10)	(11)
Fireclay	55	50
Dust Grog. . . .	—	5
No. 1 ,, . . .	5	—
No. 2 ,, . . .	10	10
No. 3 ,, . . .	20	15
No. 1 Pitchers . .	5	10
No. 2 ,, . .	5	10

CRUCIBLE MIXTURES.

1

Fireclay	35
Ball Clay	5
Dust Grog	—
No. 1 „	30
No. 2 „	20
No. 3 „	10

2

Ball Clay	40
Graphite	57
Dust Grog	3

3

Fireclay	45
Graphite	52
Dust Grog	3

4

Fireclay	50
Plumbago	5
No. 1 Grog	20
No. 2 „	25

5

Ball Clay	50
Coke	30
Graphite	12
No. 1 Grog	8

MUFFLE MIXTURES.

	(1)	(2)
Ball Clay	5	10
China Clay	35	35
No. 1 Grog	15	15
No. 2 „	20	15
No. 3 „	25	15
Sawdust	—	10

PATCHING MIXTURE FOR SAGGARS.

60 Fireclay (through 20s. lawn).
40 Grog (,, ,, ,,).

Make into a thick paste by the addition of Sodium Silicate 60° T.

MORTAR FOR FRITT KILN BOTTOMS.

Ground calcined china clay is mixed with sufficient fireclay to make the mass of suitable consistency for working purposes.

CHAPTER VI

GLAZES

THE raw materials used for glaze-making should be tested periodically in order to ascertain their purity and moisture content. The question of grain size is not so important as is the case with body materials. It should be remembered, however, that the same general rules apply as regards the effect of surface area, especially with materials such as stone, felspar, whiting, etc. (The finer the particles the lower the melting point.)

In the following recipes containing borax, stone, felspar and whiting, it is understood that borax crystals, mixed Cornish stone, Swedish felspar, and wet-ground levigated whiting respectively are to be employed.

When clear, white glazes are desired, china clay of good quality should be used.

The importance of batch mixing previous to fritting is, in general, overlooked; yet the more thoroughly this process is carried out, the lower the melting point, and the greater the homogeneity of the resultant fritt. Where possible, it is desirable to use some form of mechanical mixer.

It is advisable to run off fritts as soon as they are fluid enough to flow from the hearth. Prolonged boiling, once the fritt is thoroughly melted, serves no useful purpose, but increases the risk of damage to the brickwork, and in extreme cases large particles of the refractory bed may be dislodged and contaminate the fritt.

Fine grinding increases the fusibility and covering power of glazes. It must, however, be carried out with care and discretion, since over-grinding is accompanied by certain faults, such as "setting" in the tub, loss of adhesion after drying, and "crawling" and "rolling" during firing. The finer types of pottery glazes must be carefully "magnetted"; if it is found to be necessary to use a glaze decolorizer, an addition of a predetermined proportion of one of the body stains given on pp. 56, 57 will give satisfactory results.

The ageing of glazes is usually advantageous, the mellowness and dipping qualities being thereby improved. This remark does not apply to artistic glazes containing large proportions of raw clay or stone. Normal glazes of this nature have a tendency to crack during drying, therefore the increased plasticity given by ageing aggravates this defect. As a general rule these glazes are stiff and lacking in fluidity, consequently some of the cracks may be apparent after firing.

MOLECULAR FORMULÆ

The method of expressing pottery compounds in the form of molecular formulæ is worthy of consideration. Despite the fact that it has certain unavoidable defects, the system is of great value, provided that it is used intelligently, and its limitations are frankly recognized.

From the molecular formula of a glaze, it is possible to forecast its probable physical characteristics with a greater degree of accuracy than would be possible from a study either of the corresponding recipe or of the ultimate chemical composition. These formulæ are of the greatest utility where many changes of glaze composition have to be made, since, by their aid, it is possible to restrict the field of experiments, and thus save time.

The present work is primarily intended for practical potters. Those interested in this subject are referred to such technical treatises as *Seger's Collected Works*, the *Transactions of the Ceramic Society*, etc. Having grasped the underlying principles, the handbook, *Tables to Facilitate the Calculation of Formulæ from Analyses and Recipes*, issued by the Ceramic Society, will then be found invaluable.

CHINA, SEMI-PORCELAIN AND EARTHENWARE GLAZES, Etc.

1 EARTHENWARE GLAZE.

Fritt—	195 lbs.	Borax
	225 ,,	Stone
	68 ,,	Flint
Glaze—	250 lbs.	Fritt
	75 ,,	White Lead

2 EARTHENWARE GLAZE.

Fritt—	215 lbs.	Borax
	126 ,,	Stone
	120 ,,	Felspar
	53 ,,	China Clay
Glaze—	385 lbs.	Fritt
	113 ,,	White Lead

3 EARTHENWARE GLAZE.

Fritt—	142 lbs.	Borax
	165 ,,	Stone
	96 ,,	Flint
Glaze—	175 lbs.	Fritt
	35 ,,	White Lead

4 **CHINA TRANSPARENT GLAZE.**

Fritt—	128 lbs.	Borax
	160 ,,	Stone
	125 ,,	Flint
	82 ,,	Whiting
	2 ,,	Pearl Ash
	3 ,,	Nitre
	20 ,,	Soda Ash
	94 ,,	China Clay
Glaze—	220 lbs.	Fritt
	5 ,,	China Clay
	9 ,,	Stone
	5 ,,	Flint
	140 ,,	White Lead

5 **EARTHENWARE GLAZE.**

Fritt—	240 lbs.	Borax
	105 ,,	Stone
	102 ,,	Flint
	44 ,,	Whiting
Glaze—	130 lbs.	Fritt
	53 ,,	Stone
	44 ,,	White Lead

6 **CHINA FELSPAR GLAZE.**

Fritt—	215 lbs.	Borax
	120 ,,	Felspar
	148 ,,	Flint
	80 ,,	Whiting
Glaze—	250 lbs.	Fritt
	63 ,,	Felspar
	65 ,,	White Lead

7 EARTHENWARE RAW GLAZE.

90 lbs. Stone
50 ,, Flint
35 ,, China Clay . . .
12 ,, Flint Glass . . .
195 ,, White Lead . . .

8 CHINA GLAZE.

Fritt—125 lbs. Borax
165 ,, Stone
80 ,, Felspar
105 ,, Whiting.
15 ,, Nitre
15 ,, Flint
Glaze—150 lbs. Fritt
68 ,, Stone
50 ,, White Lead . . .

9 SOFT LEAD GLAZE.

Fritt— 175 lbs. Borax
100 ,, Stone
92 ,, Flint
47 ,, Whiting.
Glaze—280 lbs. Fritt
90 ,, Stone
15 ,, Flint
190 ,, White Lead . . .

10 CHINA GLAZE.

Fritt—100 lbs. Borax
65 „ Stone
60 „ Flint
55 „ Whiting.
20 „ China Clay

Glaze—200 lbs. Fritt
120 „ Stone
60 „ White Lead

11 HARD CHINA GLAZE.

Fritt—180 lbs. Borax
245 „ Stone
55 „ Flint
15 „ Whiting.
15 „ China Clay

Glaze—300 lbs. Fritt
150 „ Stone
35 „ Flint
100 „ White Lead

12 CHINA GLAZE.

Fritt—140 lbs. Borax
173 „ Stone
105 „ Flint
100 „ Flint Glass

Glaze—294 lbs. Fritt
60 „ White Lead

13 CHINA GLAZE LOW IN LEAD.

Fritt—	100 lbs.	Borax
	66 ,,	Stone
	50 ,,	Flint
	34 ,,	Whiting
	35 ,,	China Clay
Glaze—	230 lbs.	Fritt
	35 ,,	Stone
	30 ,,	Flint
	25 ,,	White Lead

14 EARTHENWARE GLAZE.

Fritt—	190 lbs.	Borax
	80 ,,	Stone
	110 ,,	Felspar
	80 ,,	Flint
	30 ,,	Whiting
Glaze—	440 lbs.	Fritt
	135 ,,	Stone
	110 ,,	White Lead

15 CHINA GLAZE.

Fritt—	140 lbs.	Borax
	80 ,,	Stone
	115 ,,	Whiting
	70 ,,	Flint
	25 ,,	China Clay
Glaze—	350 lbs.	Fritt
	210 ,,	Stone
	45 ,,	Flint
	130 ,,	White Lead

16 OPAQUE GLAZE.

Fritt— 20 lbs. Borax
12 „ Stone
25 „ Felspar
25 „ Flint
5 „ Bone Ash
3 „ Arsenious Oxide

Glaze— 40 lbs. Fritt
10 „ Stone
10 „ Whiting.

17 RAW OPAQUE GLAZE.

150 lbs. White Lead
45 „ Whiting.
75 „ Stone
15 „ Cryolite.
10 „ Oxide of Tin

18 GLAZE FOR ONCE-FIRED WARE (Clay dipped).

175 lbs. White Lead
125 „ China Clay
5 „ Whiting.
3 „ Calcined Borax

19 SÈVRES SOFT PASTE GLAZE

Fritt—110 lbs. Red Lead
75 „ Sand
40 „ Pearl Ash
20 „ Flint
25 „ Soda Ash

Glaze—200 lbs. Fritt
15 „ Sand

20 SEMI-PORCELAIN GLAZE.

Fritt—333 lbs. Borax
165 „ Stone
188 „ Flint
50 „ China Clay

Glaze—350 lbs. Fritt
205 „ Stone
90 „ Flint
172 „ White Lead

21 SEMI-PORCELAIN GLAZE.

Fritt—195 lbs. Borax
82 „ Felspar
80 „ Whiting
160 „ Flint
23 „ China Clay

Glaze—405 lbs. Fritt
20 „ China Clay
143 „ White Lead

22 SEMI-PORCELAIN GLAZE.

Fritt—265 lbs. Borax
105 „ Stone
100 „ Whiting
133 „ Flint
48 „ China Clay

Glaze—243 lbs. Fritt
225 „ Stone
132 „ White Lead
80 „ Flint

23 EARTHENWARE GLAZE.

Fritt—205 lbs. Borax
100 „ Felspar
108 „ Whiting
150 „ Flint.
60 „ China Clay

Glaze—475 lbs. Fritt.
90 „ Felspar
142 „ Flint
30 „ China Clay
250 „ White Lead

24 PITCHER GLAZE.

Fritt—275 lbs. Borax
115 „ Whiting
113 „ Earthenware Bis. Pitchers
26 „ China Clay
240 „ Flint.

Glaze—410 lbs. Fritt.
145 „ White Lead
10 „ China Clay

25 PITCHER GLAZE.

Fritt—195 lbs. Borax
255 „ Felspar
110 „ Whiting
70 „ Earthenware Glost Pitchers.

Glaze—480 lbs. Fritt.
73 „ Flint.
15 „ China Clay
60 „ White Lead

26 LOW SOLUBILITY GLAZE.

Lead Fritt—245 lbs. Red Lead
112 ,, Felspar
53 ,, Whiting
120 ,, Flint

Borax Fritt—187 lbs. Borax
52 ,, Whiting
95 ,, Felspar
110 ,, Flint
17 ,, China Clay

Glaze—420 lbs. Lead Fritt
307 ,, Borax Fritt
60 ,, China Clay
55 ,, Flint

27 LOW SOLUBILITY GLAZE.

Borax Fritt— 240 lbs. Borax
110 ,, Stone
100 ,, Whiting
240 ,, Flint
55 ,, China Clay

Glaze—245 lbs. Brimsdown Lead Fritt
200 ,, Borax Fritt
190 ,, Stone
30 ,, China Clay
30 ,, Flint

28 GLAZE FOR RED RING FIRING TRIALS.

3 lbs. Red Lead
1 lb. Flint

LEADLESS GLAZES.

1 LEADLESS CHINA GLAZE.

Fritt—150 lbs. Borax
270 „ Felspar
75 „ Whiting
56 „ Flint

Glaze—360 lbs. Fritt
72 „ China Clay

2 LEADLESS PRINTED GLAZE.

Fritt—100 lbs. Borax
243 „ Felspar
55 „ Whiting
55 „ Flint

Glaze—340 lbs. Fritt
50 „ China Clay

3 LEADLESS TRANSPARENT GLAZE.

Fritt— 40 lbs. Borax
30 „ Boracic Acid
90 „ Flint
20 „ China Clay
60 „ Felspar

Glaze—200 lbs. Fritt
10 „ China Clay
20 „ Flint

4 LEADLESS EARTHENWARE GLAZE.

Fritt—195 lbs. Borax
292 „ Felspar
95 „ Whiting
57 „ Flint

Glaze—610 lbs. Fritt
35 „ China Clay

5 LEADLESS COMMON GLAZE.

Fritt—150 lbs. Borax
480 „ Hard Purple Stone
90 „ Whiting.

Glaze—515 lbs. Fritt
60 „ Hard Purple Stone

6 LEADLESS GLAZE.

Fritt—180 lbs. Boracic Acid
305 „ Felspar
103 „ Flint
82 „ Whiting.

Glaze—675 lbs. Fritt
33 „ China Clay

7 LEADLESS GLAZE.

Fritt— 95 lbs. Borax
385 „ Felspar
118 „ Whiting.
85 „ Flint

Glaze—518 lbs. Fritt
30 „ China Clay
23 „ Flint

8 LEADLESS GLAZE.

Fritt—200 lbs. Borax
77 „ Whiting.
41 „ Stone
170 „ China Clay
108 „ Flint

Glaze—308 lbs. Fritt
36 „ Stone
5 „ China Clay
33 „ Flint

9 **BARIUM LEADLESS GLAZE.**

Fritt—187 lbs. Borax
98 „ Barium Carbonate
45 „ Whiting
27 „ Boracic Acid
270 „ Flint

Glaze—410 lbs. Fritt
22 „ Flint

10 **CHINA LEADLESS GLAZE.**

Fritt—195 lbs. Borax
342 „ Felspar
105 „ Flint
97 „ Whiting

Glaze—320 lbs. Fritt
142 „ China Clay

11 **GLAZE FOR FIREPROOF BODY.**

Fritt—100 lbs. Borax
75 „ Boracic Acid
20 „ Flint
100 „ Whiting
40 „ Felspar

Glaze—100 lbs. Fritt
5 „ China Clay

12 **GLAZE FOR ONCE-FIRED WARE** (Clay dipped

85 lbs. Felspar
5 „ Whiting
5 „ China Clay
35 „ Borocalcite
20 „ Barium Carbonate
30 „ Flint

PORCELAIN GLAZES

The maturing points of the following glazes are shown at the head of each recipe.

1 Cone 9 or Bar No. 28.

75 lbs. Felspar
10 „ Whiting
5 „ China Clay
10 „ Sand

2 Cone 9 or Bar No. 28.

65 lbs. Felspar
13 „ Whiting
10 „ China Clay
8 „ Sand
4 „ Barium Carbonate

3 Cone 10 or Bar No. 29.

50 lbs. Felspar
15 „ Whiting
10 „ China Clay
20 „ Quartz
5 „ Magnesium Carbonate

4 Cone 12 or Bar No. 31.

40 lbs. Felspar
12 „ Whiting
8 „ China Clay
35 „ Quartz
5 „ Magnesium Carbonate

5 Cone 15 or Bar No. 33.

30 lbs. Felspar
15 ,, Whiting
15 ,, China Clay
40 ,, Quartz

ENAMELLED FIRECLAY GLAZES (Cone 8. Bar No. 27.

1
47 lbs. Purple Stone . .
18 ,, Felspar . . .
20 ,, Flint
6 ,, Whiting . . .
5 ,, Barium Carbonate .
4 ,, Oxide of Zinc . .

2
40 lbs. Purple Stone . .
28 ,, Felspar . . .
12 ,, Flint
13 ,, Whiting . . .
7 ,, Oxide of Tin . .

3
40 lbs. Purple Stone . .
35 ,, Felspar . . .
10 ,, Flint
6 ,, Plaster . . .
6 ,, Whiting . . .
3 ,, Oxide of Zinc . .

TEAPOT GLAZES

1 SAMIAN.

Fritt—100 lbs. Borax
100 ,, Stone
50 ,, Flint
Glaze—100 lbs. Fritt
100 ,, White Lead . . .

2 **SAMIAN.**

60 lbs. White Lead
30 „ Stone
10 „ Flint

3 **ROCKINGHAM.**

55 lbs. White Lead
25 „ Stone
15 „ Flint
5 „ Oxide of Manganese

4 **ROCKINGHAM.**

65 lbs. White Lead
10 „ Stone
10 „ Flint
10 „ Red Clay
5 „ Oxide of Manganese

5 **JET.**

60 lbs. White Lead
15 „ Stone
20 „ Flint
5 „ Oxide of Cobalt

6 **OPAQUE GREEN.**

Fritt— 40 lbs. Borax
10 „ Cryolite
20 „ Stone
10 „ Flint
10 „ Whiting
10 „ Boracic Acid

Glaze—200 lbs. Fritt
3 „ Oxide of Antimony
6 „ Oxide of Chrome
10 „ Stone

ART GLAZES

Coloured Transparent Glazes.

In the compounding of any particular glaze of the above type, it is necessary to know very definitely what colours are obtainable after firing, by the addition of the simple metallic oxides to various types of white transparent glazes. The latter may be conveniently grouped into three classes :

(1) Raw Lead.
(2) Leadless, containing a large proportion of Boric Oxide.
(3) Alkaline Leadless, low in Boric Oxide.

The effect of the addition of varying amounts of a few of the principal metallic oxides to glazes of the above types, is shown in the following table.

Table I.

COLOUR MODIFICATIONS DUE TO VARIATIONS IN GLAZE COMPOSITION.

Colourant.	% of Colourant to give Transparent Glaze.	"Heavy" Lead.	"Boracic" Leadless.	"Alkaline" Leadless.	Remarks.
Oxide of Copper .	1–6	Grass Green	Bluish Green	Turquoise Blue	Red in "reducing" fire.
Oxide of Cobalt .	1–5	Blue	Blue	Blue	Pink in magnesian glazes.
Oxide of Iron . .	1–5	Yellowish Brown	Brown	Brown	"Aventurine" effects in extra rich "boracic" glazes.
Oxide of Manganese	1–5	Claret Brown	Claret Brown	Violet	Use carbonate of manganese if specially good violets are required.
Oxide of Nickel .	0·10–0·50	Straw Brown	Brown	Brown	Unsatisfactory colours. Blue in zinc glazes.
Oxide of Chrome .	0·10–0·40	Yellowish Green	Green	Green	Higher percentages in leadless glazes give opaque greens. Rich Red in extra heavy lead glazes.
Oxide of Uranium	1–6	Lemon Yellow	Yellow	Orange Yellow	Red in bismuth glazes.

The above are the results of actual experiments; all the trials were fired in a majolica tile kiln to Bar 18.

The utility of the method is readily seen by comparison of Glazes Nos. 1–12 in which Glaze A is used.

A — 65 parts White Lead
10 ,, China Clay
25 ,, Flint

	1	2	3	4
A Glaze . .	100	100	100	100
Oxide of Copper	1	2	3	4

Range of Grass Greens.

	5	6	7	8
A Glaze . .	100	100	100	100
Oxide of Iron .	1	2	3	4

Range of Yellowish Browns.

By mixing the brown and green glazes in variable proportions, shades intermediate between them are given, *e.g.*:

9 BROWNISH GREEN.

50 parts No. 4 Glaze . . }
50 ,, No. 5 ,, . . . }

10 GREENISH BROWN.

50 parts No. 8 Glaze . . }
50 ,, No. 1 ,, . . . }

Alternatively similar glazes may be compounded.

11 BROWNISH GREEN.

200 parts A Glaze . . . }
4 ,, Oxide of Copper . . }
1 part Oxide of Iron . . }

12 GREENISH BROWN.

200 parts A Glaze . . .
4 ,, Oxide of Iron . .
1 part Oxide of Copper . .

From the foregoing remarks it will be evident that, by the addition of the metallic oxides, varying both in amount and number, to white transparent glazes, an unlimited number of coloured glazes may be produced.

The fact should not be overlooked that several Underglaze Colours, *e. g.* Crimson, Pink, Matt Blue, Victoria Green are successfully used as glaze stains.

Unless otherwise stated, all the "Art" glazes will mature at Bar 18.

13 RAW MAJOLICA GLAZE.

65 lbs. White Lead . . .
15 ,, Stone
20 ,, Flint

14 RAW MAJOLICA GLAZE.

15 lbs. Borocalcite . . .
50 ,, White Lead . . .
25 ,, Flint
10 ,, Stone

15 RAW MAJOLICA GLAZE.

75 lbs. White Lead . . .
5 ,, Stone
3 ,, China Clay . . .
17 ,, Flint

16 RAW MAJOLICA GLAZE.

70 lbs. White Lead . . .
30 ,, Felspar . . .

17 **RAW MAJOLICA GLAZE.**

75 lbs. White Lead . . .
10 ,, Stone
15 ,, Flint

18 **RAW MAJOLICA GLAZE.**

65 lbs. White Lead . . .
10 ,, China Clay . . .
25 ,, Flint

19 **LEADLESS GLAZE.**

Fritt—120 lbs. Borax
40 ,, Whiting . . .
75 ,, Flint
30 ,, China Clay . . .
8 ,, Nitre
Glaze—200 lbs. Fritt
10 ,, Stone

20 **LEADLESS GLAZE.**

Fritt—150 lbs. Borax
70 ,, Flint
30 ,, Whiting . . .
45 ,, China Clay . . .
5 ,, Cryolite . . .
Glaze—225 lbs. Fritt
10 ,, Stone
10 ,, China Clay . . .

21 LEADLESS GLAZE.

Fritt— 95 lbs. Borax
40 ,, Nitre
26 ,, Whiting
50 ,, Barium Carbonate
10 ,, Boracic Acid

Glaze—135 lbs. Fritt
20 ,, Flint

22 TRANSPARENT GLAZE.

Fritt—100 lbs. Borax
40 ,, Whiting
25 ,, China Clay
100 ,, Flint

Glaze—125 lbs. Fritt
10 ,, Flint
85 ,, White Lead

23 TRANSPARENT GLAZE.

Fritt—120 lbs. White Lead
20 ,, Borax
38 ,, Stone
5 ,, Nitre
5 ,, Whiting
65 ,, Flint

Glaze—115 lbs. Fritt
15 ,, Stone

24 BARIUM GLAZE.

Fritt— 80 lbs. White Lead
25 „ Barium Carbonate
15 „ China Clay
65 „ Flint
38 „ Boracic Acid

Glaze—190 lbs. Fritt
25 „ White Lead

25 HEAVY MAJOLICA GLAZE.

Fritt— 30 lbs. Borax
50 „ Stone
20 „ Felspar
25 „ Whiting
15 „ Flint

Glaze— 55 lbs. Fritt
60 „ White Lead
10 „ Flint

26 TRANSPARENT GLAZE.

Fritt— 85 lbs. Borax
30 „ Pearl Ash
30 „ Whiting
25 „ Flint

Glaze— 80 lbs. Fritt
20 „ White Lead
20 „ Flint

27 MATT GLAZE.

80 lbs. White Lead
35 „ Felspar
20 „ Whiting
8 „ China Clay
16 „ Flint

28 **MATT GLAZE.**

75 lbs. White Lead
30 „ Felspar
9 „ Whiting
22 „ China Clay
12 „ Flint
4 „ Oxide of Zinc

29 **MATT GLAZE.**

25 lbs. White Lead
15 „ Barium Carbonate
30 „ Felspar
10 „ Whiting
5 „ China Clay
18 „ Flint
3 „ Oxide of Zinc

30 **WATER-MARKED MATT GLAZE.**

65 lbs. White Lead
25 „ Felspar
10 „ Ball Clay
20 „ Barium Carbonate

31 **MATT GLAZE.**

Fritt—100 lbs. Borax
40 „ Whiting
40 „ China Clay
60 „ Flint
20 „ Magnesium Carbonate

Glaze—120 lbs. Fritt
25 „ Stone

32 MATT GLAZE.

Fritt— 70 lbs. Borax
110 „ Stone
30 „ Flint

Glaze—130 lbs. Fritt
10 „ China Clay

33 CRAZING GLAZE FOR ANTIQUE TILE.

Fritt— 75 lbs. Borax
23 „ Stone
8 „ Felspar
5 „ Whiting
32 „ Soda Ash

Glaze— 40 lbs. Fritt
45 „ White Lead
15 „ Stone

34 CRAZING GLAZE FOR ANTIQUE TILE.

Fritt— 50 lbs. Flint
5 „ Stone
5½ „ Whiting
21½ „ China Clay
43 „ Soda Ash

Glaze— 90 lbs. Fritt
5 „ Stone
5 „ Flint

35 OPALESCENT GLAZE.

Fritt— 60 lbs. Boracic Acid
130 „ Flint
55 „ Whiting
65 „ Nitre

Glaze—115 lbs. Fritt
15 „ White Lead

36 OPALESCENT GLAZE.

Fritt—120 lbs. Borax
38 ,, Whiting
10 ,, Pearl Ash
85 ,, Flint

Glaze— 85 lbs. Fritt
5 ,, Fluorspar

37 AVENTURINE GLAZE.

30 lbs. Borax
35 ,, Flint
5½ ,, Stone
2½ ,, Nitre
6 ,, Oxide of Iron
¼ lb. Oxide of Copper
2 ozs. Barium Chromate
Fritt and grind for use.

38 AVENTURINE GLAZE.

Fritt—100 lbs. Borax
35 ,, Flint
8 ,, Whiting
15 ,, White Lead

Glaze— 70 lbs. Fritt
5 ,, Stone
6 ,, Oxide of Iron
¼ lb. Oxide of Copper
¼ ,, Chromate of Iron

39 **AVENTURINE GLAZE.**

Fritt—40 lbs. Borax
10 „ Boracic Acid
20 „ White Lead
40 „ Flint
30 „ Oxide of Iron

Glaze—60 lbs. Fritt
10 „ White Lead
¼ lb. Oxide of Copper

40 **BRIGHT RED GLAZE.**

Fritt—5 lbs. Boracic Acid
2 „ Whiting
3 „ China Clay
10 „ Flint
30 „ Red Lead

Glaze—1 lb. Fritt
¼ „ Oxide of Bismuth
¼ „ Oxide of Uranium

41 **OPAQUE TURQUOISE GLAZE.**

Fritt—11 lbs. White Lead
5 „ Whiting
7 „ Pearl Ash
13½ „ Soda Crystals
41 „ Flint
3 „ China Clay

Glaze—60 lbs. Fritt
7 „ White Lead
5 „ China Clay
5 „ Flint
8 „ Oxide of Tin
2 „ Oxide of Copper

42 TRANSPARENT TURQUOISE GLAZE.

Fritt—	65 lbs.	Sand
	25 „	Nitre
	18 „	Soda Ash . . .
	15 „	Red Lead . . .
Glaze—	85 lbs.	Fritt
	5 „	Sand

43 CRIMSON GLAZE.

Fritt—	20 lbs.	Borax
	10 „	Boracic Acid . .
	10 „	Nitre
	45 „	Whiting . . .
	65 „	Flint
	5 „	China Clay . . .
Glaze—	70 lbs.	Fritt
	14 „	White Lead . . .
	6 „	Flint
	10 „	U. G. Crimson, No. 68 .

44 LEADLESS CRIMSON GLAZE.

Fritt—	150 lbs.	Borax
	25 „	Whiting . . .
	60 „	Flint
	10 „	Cryolite. . . .
	40 „	China Clay . . .
Glaze—	160 lbs.	Fritt
	10 „	Fluorspar . . .
	15 „	U. G. Crimson, No. 68 .

45 **VIOLET GLAZE.**

Fritt—25 lbs. Borax
18 „ Pearl Ash
8 „ White Lead
30 „ Flint

Glaze—25 lbs. Fritt
4 „ White Lead
6 „ Flint
1 lb. Carbonate of Manganese.

46 **DOUBLE DIPPED GLAZES.**

25 lbs. Glaze, No. 31. Page 85
2 „ Oxide of Iron
3 „ Oxide of Zinc
2 „ Rutile

47

25 lbs. Glaze, No. 19. Page 82
2 „ Bone Ash
2½ „ Tin Ash

48

25 lbs. Glaze, No. 13. Page 81
2 „ Rutile
1 lb. Oxide of Chrome

49

25 lbs. Glaze, No. 20. Page 82
3 „ Cryolite
1 „ Oxide of Tin

50

25 lbs. Glaze, No. 15. Page 81 .
2 „ Oxide of Copper .
2 „ Oxide of Zinc .

51

25 lbs. Glaze, No. 20. Page 82 .
3 „ Fluorspar .
1 lb. Oxide of Antimony .

52

25 lbs. Glaze, No. 18. Page 82 .
1½ „ Oxide of Copper .
1½ „ Rutile .
½ b. Oxide of Nickel .

53

25 lbs. Glaze, No. 21. Page 83 .
2 „ Barium Carbonate .
1½ „ Oxide of Tin .

NOTE.—Glazes Nos. 1–53 all mature at Bar 18.

54 COPPER RED GLAZE { Cone 05. Bar No. 19.

Fritt—45 lbs. Borax .
12 „ Soda Ash .
10 „ Nitre .
10 „ Whiting .
70 „ Flint .
Glaze—18 lbs. Fritt .
2 „ White Lead .
1½ „ Oxide of Tin .
3 ozs. Oxide of Copper .

In reducing atmosphere.

55 **COPPER RED GLAZE** { Cone 05. Bar No. 19.

Fritt—15 lbs. Borax
4 „ Pearl Ash
7 „ Stone
25 „ Red Lead
25 „ Sand

Glaze—10 lbs. Fritt
1 lb. China Clay
¼ „ Bismuth Nitrate
¼ „ Carbonate of Silver
2 ozs. Carbonate of Copper
2 „ Oxide of Tin

In reducing atmosphere.

56 **CHROME RED GLAZE** { Cone 015. Bar No. 7.

Fritt—25 lbs. Litharge
2 „ Pearl Ash
5 „ Flint
3 „ Red Chromate of Lead

Glaze—10 lbs. Fritt
3 ozs. China Clay

57 **OPALESCENT GLAZE** { Cone 1. Bar No. 23.

Fritt—12 lbs. Boracic Acid
4 „ Barium Carbonate
6 „ Whiting
19 „ Nitre
3 „ White Lead
25 „ Flint

Glaze—40 lbs. Fritt
2 „ White Lead
2 „ Fluorspar
2 „ Flint

58 **MATT GLAZE** { Cone 02. Bar No. 21.

Fritt— 8 lbs. Borax
4 ,, Whiting
2 ,, Boracic Acid
4 ,, Nitre
16 ,, Oxide of Zinc
20 ,, Flint

Glaze—30 lbs. Fritt
10 ,, Flint

59 **MATT GLAZE** { Cone 1. Bar No. 23.

30 lbs. White Lead
25 ,, Felspar
7 ,, Barium Carbonate
3 ,, China Clay

60 **MATT GLAZE** { Cone 1. Bar No. 23.

Fritt—12 lbs. Borax
20 ,, Felspar
20 ,, Barium Carbonate
15 ,, Fluorspar
10 ,, Flint
10 ,, China Clay

Glaze—20 lbs. Fritt
1½ ,, Flint
¾ lb. Oxide of Zinc

61 **MATT GLAZE** { Cone 6. Bar No. 26.

19	lbs.	Felspar
7	,,	Whiting
7	,,	Barium Carbonate
3	,,	Oxide of Zinc
2½	,,	Oxide of Tin
5	,,	China Clay
12	,,	Flint

62 **CRYSTALLINE GLAZE** { Cone 1. Bar No. 23.

25	lbs.	Lead Borate
6	,,	Whiting
10	,,	Felspar
10	,,	Flint
7	,,	Oxide of Zinc
3	,,	Rutile
¼	lb.	Oxide of Copper

63 **CRYSTALLINE GLAZE** { Cone 1. Bar No. 23.

Fritt—12	lbs.	Borax
3	,,	Barium Carbonate
1½	,,	Whiting
3	,,	Felspar
3	,,	Pearl Ash
16	,,	Flint
6	,,	Oxide of Zinc
Glaze—20	lbs.	Fritt
2	,,	China Clay
2	,,	Rutile
¼	lb.	Oxide of Iron
1	,,	Oxide of Zinc

64 CRYSTALLINE GLAZE { Cone 7. Bar No. 26A.

Fritt—17 lbs. Borax
6 „ Boracic Acid
10 „ Barium Carbonate
8 „ Whiting
6 „ Nitre
24 „ Flint

Glaze—25 lbs. Fritt
1½ „ Flint
2 „ China Clay
12 „ Oxide of Zinc
2½ „ Rutile
2 ozs. Oxide of Cobalt (Prep.)

65 CRYSTALLINE GLAZE { Cone 3. Bar No. 25.

Fritt—15 lbs. Borax
5 „ Soda Ash
2 „ Whiting
3 „ China Clay
25 „ Flint

Glaze—20 lbs. Fritt
10 „ Oxide of Zinc
2 „ Rutile
2 ozs. Oxide of Nickel

NOTE.—Irregular results are frequently met with when dealing with certain glazes, and in many instances the trouble may be traced to inattention to mechanical details. Texture, matt and opalescent glazes are susceptible to slight changes in the thickness of the glaze layer, others, *e. g.* Violets, Crystallines and Aventurines, require special firing and cooling treatment.

CHAPTER VII

COLOURS, LUSTRES, ETC.

PRINTING colours always require a larger proportion of base to diluent, or flux, than is the case with colours used for banding or aerographing, since in the latter processes a much thicker layer is applied to the ware than is transferred from a copper plate. The right kind of flux will in many instances assist in the development of the particular tint required. When the composition of the material to be used as a diluent is not an important consideration, then ground earthenware, china or parian pitchers may be employed with good results.

Apart from the actual recipe itself, the working methods adopted during its preparation also affect the final colour. To ensure the best results, attention should be given to the following items:

(1) All raw materials should conform to a known standard as regards purity and moisture content.

(2) After the various ingredients comprising the colour have been weighed out, they must be intimately mixed and passed through a 40s lawn. In cases where small amounts of colourants soluble in water are required, it is advantageous to add them in the form of a solution if possible. In colours marked *, the bichromate may be dissolved in water and added to the previously mixed materials. The pasty mass is then well kneaded and dried.

(3) The " Heat Treatment " required to give satisfactory results is indicated with each recipe.

Most colours need a good supply of air during calcination, hence the necessity of distributing them in thin layers. Certain greens, however, are much improved by calcining them under slightly reducing conditions. Colours which sinter during calcination may safely be treated in deeper vessels. The dishes, pots, etc., in which the colours are calcined, are best coated with flint on those parts likely to come into contact with the mixture. Pieces of flint or pitcher adhering to the calcined mass should be removed prior to grinding or recalcination.

(4) *Grinding.*—This is, of course, a necessity, and in the majority of cases will do no harm if carried to excess. With certain dry colours, however, such as matt blue, pink, green, etc., practical experience shows that over-grinding tends to make the colours " crawl " and " peel."

(5) *Washing.*—All colours must be washed after grinding. For ordinary colours, thorough washing with cold water is sufficient; others, such as matt blue, pink, green, etc., are best treated with hot water until the washings are colourless. The removal of soluble chromates is facilitated by using water slightly acidulated with hydrochloric acid.

UNDERGLAZE COLOUR FLUXES.

1

11 lbs. Borax	Easy Earthenware Glost.
9½ „ Flint	

2

14½ lbs. Flint Glass	Easy Earthenware Glost.
13 „ Lynn Sand	

3

8 lbs. Red Lead	Easy Earthenware Glost.
1 lb. Borax	
4 lbs. Flint	

4 **FLOW BLUE FLUX.**

7 lbs.	Borax	Earthenware Glost.
4 „	Stone	
2 „	Whiting	
5 „	Flint	

5 **MATT BLUE FLUXES.**

10 lbs.	Red Lead	Hard Kiln.
3½ „	Borax	
1½ „	Flint	

6

20 lbs.	Red Lead	Hard Kiln.
8 „	Borax	
9 „	Flint	

7

14 lbs.	Parian Pitchers	Earthenware Biscuit.
2½ „	Red Lead	
2 „	Flint	

8 **PINK FLUXES.**

7 lbs.	Red Lead	Easy Earthenware Glost.
4½ „	Borax	
1½ „	Felspar	
1½ „	Whiting	
4 „	Flint	

9

21 lbs.	Earthenware Pitchers	Earthenware Biscuit.
3 „	Whiting	
7 „	Stone	

UNDERGLAZE COLOUR RECIPES.

1 **MATT BLUE.**

4 lbs.	Oxide of Zinc	China Biscuit.
1 lb.	Oxide of Cobalt (Prep.)	
1 ,,	Oxide of Tin	
16 lbs.	Alumina Hydrate	

2 **MATT BLUE.**

5 lbs.	Oxide of Zinc	China Biscuit.
½ lb.	Oxide of Cobalt (Prep.)	
10 lbs.	Calcined Alumina	

3 **MATT BLUE.**

4 lbs.	Oxide of Zinc	Earthenware Biscuit.
1½ ,,	Oxide of Cobalt (Prep.)	
4 lbs.	Base	Earthenware Glost.
5½ ,,	No. 8 Flux. Page 118	

4 **CELESTE.**

8 lbs.	Oxide of Zinc	China Biscuit.
3 ,,	Oxide of Cobalt (Prep.)	
10 ,,	Alumina Hydrate	

5 **WILLOW BLUE.**

10 lbs.	Oxide of Cobalt (Prep.)	Earthenware Biscuit.
5 ,,	Flint	
15 ,,	Whiting	

6 **CANTON BLUE.**

11½ lbs.	Oxide of Cobalt (Black)	Earthenware Biscuit.
1½ ,,	Flint	
2½ ,,	Whiting	
1½ ,,	Barium Carbonate	

7 **BROSELEY BLUE.**

5¼ lbs.	Oxide of Cobalt (Prep.)	Earthenware Glost.
9 „	Flint	
5½ „	Flint Glass	

8 **STRONG WILLOW BLUE.**

11½ lbs.	Oxide of Cobalt (Prep.)	Earthenware Glost.
2 „	Flint	
2 „	Flint Glass	

9 **BAMBOO BLUE.**

4¼ lbs.	Oxide of Cobalt (Black)	Earthenware Biscuit.
2½ „	Parian Pitchers	

10 **AMOY BLUE.**

3¾ lbs.	Oxide of Cobalt (Black)	Earthenware Biscuit.
6 „	Parian Pitchers	

11 **EDGING BLUE.**

5½ lbs.	Oxide of Cobalt (Prep.)	Earthenware Glost.
5 „	Whiting	
4 „	White Lead	
3½ „	Flint	

12 **BLUE FOR CHINA.**

5 lbs.	Oxide of Cobalt (Prep.)	Earthenware Glost.
10 „	Flux No. 2	

13 **BLUE FOR EARTHENWARE.**

12 lbs.	Base No. 15	Earthenware Glost.
4½ „	Flux No. 1	

14 **PHEASANT BLUE.**

3½ lbs.	Oxide of Cobalt (Prep.)	Earthenware Glost.
8½ ,,	Flux No. 6	

15 **BANDING BLUE BASE.**

15 lbs.	Oxide of Cobalt (Prep.)	Earthenware Biscuit.
8 ,,	Flint	
3 ,,	Nitre	

16 **BANDING BLUE.**

10½ lbs.	Base, No. 15	Earthenware Glost.
4 ,,	Red Lead	
3½ ,,	Stone	

17 **CHEAP BLACK.**

18 lbs.	Chromate of Iron	Earthenware Biscuit.
2 ,,	Oxide of Cobalt (Black)	

18 **DEAD BLACK.**

8 lbs.	Chromate of Iron	Earthenware Biscuit.
3¼ ,,	Oxide of Cobalt (Black)	
1¼ ,,	Oxide of Nickel	
1 lb.	Oxide of Tin	
1¼ lbs.	Iron Scales	

19 **BLACK.**

6 lbs.	Chromate of Iron	Earthenware Biscuit.
2 ,,	Iron Scales	
2½ ,,	Oxide of Nickel	
2 ,,	Oxide of Manganese	
3 ,,	Blue Calx { 9 Cobalt / 1 Red Lead	

20 **BLACK.**

1¾ lbs.	Oxide of Manganese	Earthenware Biscuit.
7½ „	Oxide of Iron	
7 „	Oxide of Chrome	
2 „	China Clay	

21 **BLACK.**

7 lbs.	Oxide of Iron	Earthenware Biscuit.
7 „	Oxide of Chrome	
1½ „	Oxide of Cobalt (Black)	
5 „	China Clay	

22 **BLACK.**

7 lbs.	Oxide of Iron	Earthenware Biscuit.
5½ „	Oxide of Chrome	
3½ „	Oxide of Cobalt (Black)	
1 lb.	Oxide of Manganese	

23 **BLACK.**

1¼ lbs.	Oxide of Iron	Earthenware Biscuit.
9½ „	Oxide of Chrome	
2½ „	Oxide of Cobalt (Black)	
1½ „	Oxide of Manganese	

24 **BLACK.**

15 lbs.	Chromate of Iron	Earthenware Biscuit.
4½ „	Oxide of Nickel	
¾ lb.	Oxide of Cobalt (Black)	
2 lbs.	Iron Scales	

25 **BROWN.**

6¼ lbs.	Chromate of Iron	Earthenware Glost.
1 lb.	Oxide of Manganese	
½ „	Crude Antimony	
½ „	Red Lead	

26 **RED BROWN.**

4½ lbs.	Oxide of Iron	Earthenware Biscuit.
4 „	Oxide of Chrome	
5 „	Oxide of Zinc	

27 **DARK BROWN.**

9 lbs.	Oxide of Manganese	Earthenware Biscuit.
7½ „	Chromate of Iron	

28 **BROWN.**

2 lbs.	Oxide of Manganese	Earthenware Glost.
6 „	Chromate of Iron	
1 lb.	Calcined Umber	
¼ „	Red Lead	

29 **CLARET BROWN.**

15 lbs.	Oxide of Zinc	Earthenware Glost.
3¼ „	Oxide of Iron	
3 „	Oxide of Chrome	
2½ „	Litharge	
2 „	Boracic Acid	

30 **SEPIA BROWN.**

2½ lbs.	Oxide of Zinc	Earthenware Biscuit.
6¼ „	Oxide of Iron	
6¾ „	Oxide of Chrome	
6 „	Calcined Alumina	

31 **VANDYKE BROWN.**

15 lbs.	Chromate of Iron	Hard Earthenware Glost.
8 „	Oxide of Manganese	
2½ „	Oxide of Zinc	

32 **VIOLET BROWN.**

1¼ lbs.	Carbonate of Manganese	Easy Earthenware Glost.
3 ,,	Pearl Ash	
1½ ,,	Red Lead	
6 ,,	Flint	

33 **BROWN.**

5½ lbs.	Chromate of Iron	Earthenware Glost.
2¼ ,,	Oxide of Manganese	
1 lb.	Crude Antimony	
1 ,,	Crocus Martis	
½ ,,	Red Lead	

34 **CHOCOLATE.**

4½ lbs.	Oxide of Iron	Earthenware Biscuit.
3 ,,	Oxide of Chrome	
8¼ ,,	Oxide of Zinc	
¾ lb.	China Clay	

35 **BROWN.**

4½ lbs.	Oxide of Manganese	Earthenware Biscuit.
1 lb.	Oxide. of Chrome	
4 lbs.	Stone	

36 **BROWN.**

3 lbs.	Chromate of Iron	Earthenware Biscuit.
8½ ,,	Oxide of Zinc	
4 ,,	China Clay	

37 **OLIVE GREEN.**

3¼ lbs.	Oxide of Nickel	Earthenware Glost.
2 ,,	Oxide of Cobalt (Black)	
1 lb.	Iron Scales	
5 lbs.	Flux, No. 1	

38 **MARINE GREEN.**

5 lbs.	Oxide of Chrome	Hard Earthenware Biscuit.
2¾ ,,	Oxide of Cobalt (Prep.)	
3 ,,	Oxide of Zinc	
4½ ,,	Whiting	

39 **GORDON GREEN.**

4 lbs.	Oxide of Chrome	Earthenware Glost.
3½ ,,	Oxide of Zinc	
6 ,,	Flint	
1 lb.	Flux, No. 1	

40 **BLUISH GREEN.**

3½ lbs.	Oxide of Chrome	Easy Earthenware Glost.
7½ ,,	Oxide of Zinc	
2 ,,	Oxide of Cobalt (Prep.)	
1½ ,,	Pearl Ash	
1½ ,,	Flint	
8 ,,	Flux, No. 1	

41 **BLUISH GREEN.**

5½ lbs.	Oxide of Chrome	Earthenware Biscuit.
2 ,,	Oxide of Cobalt (Prep.)	
4 ,,	Flint	
2 ,,	Parian Pitchers	

42 **OLIVE GREEN.**

4½ lbs.	Oxide of Chrome	Easy Earthenware Glost.
2 ,,	Oxide of Nickel	
7½ ,,	Calcined Borax	
9 ,,	Flint	

43 **LEAF GREEN.**

8½ lbs.	Oxide of Chrome	Earthenware Glost.
3½ „	Oxide of Cobalt (Prep.)	
6 „	Oxide of Zinc	
8 „	Borax	
12 „	Flint	

44 **PARIS GREEN.**

6 lbs.	Oxide of Chrome	Earthenware Glost.
1 lb.	Oxide of Cobalt (Prep.)	
2 lbs.	Oxide of Zinc	
3 „	Whiting	
2 „	Borax	
10 „	Flint	

45 **SAGE GREEN.**

6 lbs.	Oxide of Chrome	Hard Earthenware Biscuit.
2½ „	Felspar	
16 „	Flint	

46 **VICTORIA GREEN.**

2¼ lbs.	Yellow Chromate of Lead	Earthenware Glost.
3½ „	Whiting	
3½ „	Flint	
3 „	Bichromate of Potash*	

47 **VICTORIA GREEN.**

5 lbs.	Yellow Chromate of Lead	Earthenware Glost.
15 „	Whiting	
15 „	Flint	
3 „	Sugar of Lead	

48 **VICTORIA GREEN.**

3 lbs.	Whiting	Earthenware Glost.
3 ,,	Flint	
5 ,,	Chloride of Lime	
4 ,,	Bichromate of Potash*	

49 **VICTORIA GREEN.**

4 lbs.	Whiting	Earthenware Glost.
4½ ,,	Flint	
3½ ,,	Bichromate of Potash*	
1½ ,,	Fluorspar	
1 lb.	Plaster	

50 **VICTORIA GREEN.**

8 lbs.	Whiting	Easy Earthenware Glost.
6½ ,,	Flint	
3½ ,,	White Lead	
6 ,,	Bichromate of Potash*	

51 **DOVE.**

1½ lbs.	Oxide of Cobalt (Black)	Easy Earthenware Biscuit.
1½ ,,	Oxide of Zinc	
9 ,,	Oxide of Nickel	
2 ,,	Stone	

52 **VIOLET**

10 lbs.	Pink, No. 73	Earthenware Glost.
1 lb.	Oxide of Cobalt (Prep.)	
½ ,,	Barium Carbonate	
½ ,,	Flint	

53 **LILAC.**

2½ lbs.	Yellow Chromate of Lead	Easy Earthenware Biscuit.
3 ,,	Oxide of Zinc	
5½ ,,	Oxide of Tin	
¾ lb.	Oxide of Cobalt (Prep.)	
1¼ lbs.	Alumina Hydrate	

54 **LILAC.**

2 lbs.	Yellow Chromate of Lead	Earthenware Glost.
1¼ ,,	Oxide of Cobalt (Prep.)	
3½ ,,	Oxide of Zinc	
3½ ,,	Oxide of Tin	
1 lb.	Alum (Potass.)	

55 **UNIQUE.**

7½ lbs.	Oxide of Tin	Easy Earthenware Glost.
3½ ,,	Oxide of Cobalt (Prep.)	
1½ ,,	Bichromate of Potash	
1 lb.	Boracic Acid	

56 **BLUE MULBERRY.**

3 lbs.	Oxide of Cobalt (Black)	Easy Earthenware Biscuit.
13½ ,,	Oxide of Manganese	
3 ,,	Felspar	

57 **BLUE MULBERRY.**

1¼ lbs.	Oxide of Cobalt (Black)	Easy Earthenware Biscuit.
4 ,,	Oxide of Manganese	
1¼ ,,	Parian Pitchers	

58 **MULBERRY.**

9 lbs.	Oxide of Manganese	Easy Earthenware Glost.
2½ ,,	Nitre	
1½ ,,	Borax	
1 lb.	Flint.	

59 **MULBERRY.**

1¼ lbs.	Oxide of Cobalt (Black)	Earthenware Biscuit.
4 ,,	Oxide of Manganese	
4 ,,	Oxide of Tin	
1 lb.	Chromate of Iron	
1 ,,	Flint	

60 **SLATE.**

3¾ lbs.	Oxide of Cobalt (Black)	Earthenware Biscuit.
1¾ ,,	Oxide of Manganese	
3½ ,,	Chromate of Iron	
4 ,,	Flint	

61 **NEUTRAL.**

5 lbs.	Bamboo Blue, No. 9	Earthenware Glost.
3 ,,	Black, No. 20	
1½ ,,	Flint Glass	

62 **NEUTRAL.**

10 lbs.	Oxide of Manganese	Earthenware Biscuit.
3½ ,,	Oxide of Cobalt (Black)	
1 lb.	Oxide of Chrome	
1 ,,	China Clay	
1 ,,	Flint	

63 **STRONG PINK BASE.**

10½ lbs.	Oxide of Tin	China Biscuit.
5 ,,	Whiting	
2 ozs.	Oxide of Chrome	

64

12 lbs.	No. 63, Base	Earthenware Biscuit.
9 ,,	Flint	
10 ,,	Whiting	

65 **PINK.**

10½ lbs.	Oxide of Tin	Earthenware Biscuit.
6 ,,	Whiting	
10 ozs.	Red Lead	
5 ,,	Bichromate of Potash*	

66 **PINK.**

14½ lbs.	Oxide of Tin	China Biscuit.
6 ,,	Whiting	
1 lb.	Bichromate of Potash*	

67 **ROSE PINK.**

14 lbs.	Oxide of Tin	Earthenware Biscuit.
3 ,,	Whiting	
2 ,,	Flint	
6 ozs.	Yellow Lead Chromate	

68 **PINK.**

11½ lbs.	Oxide of Tin	China Biscuit.
5¼ ,,	Whiting	
1 lb.	Chloride of Lime	
3 ozs.	Oxide of Chrome	

69 **PINK.**

6 lbs.	Tin Ash	Earthenware Biscuit.
2½ ,,	Whiting	
1½ ,,	Lynn Sand	
2 ,,	Borax	
4 ozs.	Yellow Lead Chromate	

70 **PINK.**

12 lbs.	Tin Ash	China Biscuit.
4 ,,	Whiting	
2 ,,	Bone Ash	
½ lb.	Yellow Lead Chromate	

71 **PINK.**

15 lbs. Oxide of Tin	China Biscuit.
4 „ Whiting	
3½ „ Fluorspar	
½ lb. Bichromate of Potash*	

72 **PERSIAN PINK.**

4½ lbs. Oxide of Tin	Earthenware Biscuit.
2 „ Whiting	
11 „ Stone	
3 ozs. Oxide of Chrome	

73 **PINK.**

13 lbs. Oxide of Tin	China Biscuit.
6 „ Whiting	
¼ lb. Calcium Borate	
½ „ China Clay	
½ „ Bichromate of Potash*	

74 **CRIMSON.**

8 lbs. Pink, No. 66	Grind for use.
¾ lb. Flint	

75 **BANDING PINK.**

15 lbs. Pink, No. 66	Grind for use.
1 „ Red Lead	

76 **CRIMSON.**

11 lbs. Oxide of Tin	China Biscuit.
4 „ Whiting	
2 „ China Pitchers	
1 lb. Fluorspar	
5 lbs. Flint	
6 ozs. Bichromate of Potash*	

77 ROSE PINK.

10 lbs.	Oxide of Tin	China Biscuit.
2 ,,	Whiting	
1 lb.	Fluorspar	
3 ozs.	Bichromate of Potash*	

YELLOW, ORANGE AND FAWN.

All to be calcined on dishes in easy Earthenware Glost Oven.

78 YELLOW.

7½ lbs.	Potassium Antimoniate
11 ,,	Red Lead
6 ,,	Oxide of Iron

79 YELLOW.

4 lbs.	Crude Antimony
4 ,,	Red Lead
8 ,,	Tin Ash
¼ lb.	Nitre

80 YELLOW.

3 lbs.	Crude Antimony
6 ,,	Red Lead
2 ,,	Oxide of Tin
¼ lb.	Nitre

81 LIGHT YELLOW.

11½ lbs.	Crude Antimony
10 ,,	Red Lead
2½ ,,	Oxide of Tin
2¾ ,,	Calcined Alumina
1 lb.	Nitre

82 YELLOW.

9 lbs. Rutile .
1½ „ China Clay .
2¾ „ Felspar .

83 ORANGE.

4 lbs. Crude Antimony .
6 „ Red Lead .
2 „ Crocus Martis .
1½ „ Oxide of Tin .

84 ORANGE.

4¼ lbs. Crude Antimony .
3 „ Red Lead .
1¼ „ Crocus Martis .
½ lb. Oxide of Tin .
1½ lbs. Alum (Potash) .

85 ORANGE.

4½ lbs. Rutile .
3½ „ Oxide of Tin .
2 „ Oxide of Zinc .
2 „ China Clay .

86 FAWN.

5 lbs. Oxide of Tin .
1¼ „ Oxide of Zinc .
1 lb. Oxide of Iron .
1 „ Yellow Chromate of Lead .

MIXED UNDERGLAZE COLOURS

The various materials only need grinding together for use.

87 **PURPLE.**

15 lbs. Pink, No. 64
1¼ „ Blue, No. 13

88 **DOVE.**

2¼ lbs. Blue, No. 13
1½ „ Pink, No. 64
1 lb. Brown, No. 27
6 lbs. Stone

89 **BUFF.**

3 lbs. Orange, No. 84
3½ „ Yellow, No. 79

90 **RED BROWN.**

14½ lbs. Pink, No. 64
5½ „ Brown, No. 27

91 **LIGHT FAWN.**

10½ lbs. Pink, No. 64
4 „ Orange, No. 84
½ lb. Yellow, No. 78

92 **FAWN.**

7 lbs. Pink, No. 63
3½ „ Orange, No. 83

93 **CANTON.**

8 lbs. Black, No. 17
3 „ Oxide of Cobalt (Black)

94 **DOVE.**

3 lbs. Oxide of Cobalt (Black)
2 ,, Pink, No. 66
1 lb. Brown, No. 27
10½ lbs. Stone

95 **LAVENDER.**

3 lbs. Black, No. 19
2½ ,, Blue, No. 8
1½ ,, Pink, No. 65

96 **UNIQUE.**

10 lbs. Pink, No. 65
¾ lb. Oxide of Cobalt (Prep.)

97 **SLATE.**

1½ lbs. Oxide of Cobalt (Black)
1½ ,, Pink, No. 65
1 lb. Brown, No. 27
13½ lbs. Stone

98 **NEUTRAL.**

5½ lbs. Blue, No. 10
3½ ,, Black, No. 20
2½ ,, Flint

FLOW POWDERS

1

5 lbs. Red Lead
2 ,, Common Salt
2 ,, Slaked Lime

2

2 lbs. Red Lead
5 ,, Slaked Lime
½ lb. Common Salt
¼ ,, Nitre

3

4½ lbs. Sodium Nitrate
1½ ,, Slaked Lime
1 lb. Red Lead

4

3 lbs. Paris White
½ lb. Common Salt
½ ,, Borax

5

3 lbs. Paris White
¼ lb. Nitre
¼ ,, Borax
¼ ,, Sal Ammoniac

NOTE: 4 and 5 do not contain lead.

ENAMEL COLOURS

Bases.—Gold colours are dealt with separately on pp. 135–139.

The preparation of ordinary enamel colour bases, as regards raw materials, calcination, etc., follow the lines laid down for underglaze colours (see p. 96). Certain delicate enamel bases, however, such as iron reds, require special consideration. In this class, the tint is governed to a great extent by the heat treatment they receive during calcination.

In addition to the recipes given on pp. 119–124, certain underglaze colours can be used as enamel bases with good effect.

Fluxes.—The proportion of base to flux affects the final colour. Besides this, the type of flux employed is a factor which is often overlooked or under-estimated. Iron reds, greys, and gold colours are particularly susceptible to change of flux; full advantage of this should therefore be taken to obtain pure colours. Large quantities of flux can be readily melted in reverberatory furnaces, but where only small quantities are required, the fritting may be done in thickly flinted crucibles, pots, etc.

Grinding.—To ensure evenness of tone, the base and flux should be ground together.

ENAMEL FLUXES

1

20 lbs.	Red Lead	Easy Earthenware Glost.
8 „	Flint	

2

11 lbs.	Borax	Easy Earthenware Glost.
9 „	Flint	

3

11 lbs.	Red Lead	Easy Earthenware Glost.
2 „	Flint	
4½ „	Boracic Acid . . .	

4

5 lbs.	Red Lead	Enamel Kiln.
9 „	Boracic Acid . . .	

5

8 lbs.	Red Lead	Easy Earthenware Glost.
1½ „	Borax	
3 „	Flint	

6

11 lbs.	Red Lead	Enamel Kiln.
2 ,,	Flint Glass	
4 ,,	Boracic Acid . . .	

7

8 lbs.	Flint Glass	Easy Earthenware Glost.
2 ,,	Borax	
9 ,,	Flint	

8

15 lbs.	Red Lead	Easy Earthenware Glost.
10 ,,	Borax	
5 ,,	Flint	

9

20 lbs.	Red Lead	Easy Earthenware Glost.
4 ,,	Borax	
7 ,,	Flint	

10

18 lbs.	Red Lead	Easy Earthenware Glost.
7 ,,	Borax	
$3\frac{1}{2}$,,	Flint	

11

10 lbs.	Red Lead	Easy Earthenware Glost.
5 ,,	Borax	
$1\frac{1}{2}$,,	Flint	

12

3 lbs.	Red Lead	Earthenware Biscuit.
3 ,,	Boracic Acid . . .	
13 ,,	Flint	

13

10 lbs.	Red Lead	Enamel Kiln.
9 ,,	Flint Glass	
6 ,,	Borax	

14

7 lbs.	Red Lead	Hard Kiln.
7½ „	Flint Glass	
1½ „	Borax	
2 „	Flint	

15

5 lbs.	Red Lead	Hard Kiln.
10 „	Flint Glass	
10 „	Borax	
7 „	Flint	

16

10 lbs.	Red Lead	Hard Kiln.
10 „	Litharge	
12 „	Borax	
10 „	Flint Glass	

17

12 lbs.	Red Lead	Easy Earthenware Glost.
1 lb.	Calcined Borax	
4 lbs.	Flint	

18

9 lbs.	Borax	Easy Earthenware Glost.
3 „	Flint Glass	
1½ „	Stone	

ENAMEL BASES

1

FRENCH BROWN.

2¾ lbs.	Oxide of Zinc	Earthenware Glost.
2 „	Chromate of Iron	
1 lb.	Red Lead	

2 SEPIA BROWN.

3¾ lbs.	Oxide of Zinc	Hard Earthenware Glost.
1½ ,,	Oxide of Chrome	
4½ ,,	Oxide of Manganese	

3 CHOCOLATE BROWN.

3 lbs.	Oxide of Zinc	Hard Earthenware Glost.
1½ ,,	Chromate of Iron	
2 ,,	Sienna	
¾ lb.	Yellow Lead Chromate	

4 KING'S BLUE.

3 lbs.	Carbonate of Cobalt	Easy Earthenware Glost.
4½ ,,	Pearl Ash	
3 ,,	Lynn Sand	

5 STRONG BLUE.

6½ lbs.	Oxide of Cobalt (Prep.)	Hard Earthenware Biscuit.
2¾ ,,	Stone	
1 lb.	Flint	
¾ ,,	Whiting	

6 PEACOCK BLUE.

2 lbs.	Oxide of Cobalt (Prep.)	Hard Earthenware Biscuit.
1 lb.	Oxide of Chrome	
6 lbs.	Prepared Alum	

7 MATT BLUE.

1¼ lbs.	Oxide of Cobalt (Prep.)	Earthenware Glost.
6 ,,	Oxide of Zinc	
3 ,,	Boracic Acid	

8 **STRONG SKY BLUE.**

3 lbs.	Oxide of Cobalt (Prep.)	Earthenware Biscuit.
6¼ ,,	Oxide of Zinc	
1¼ ,,	Flint	
¾ lb.	Salts of Tartar	

9 **MATT BLUE.**

2¼ lbs.	Oxide of Cobalt (Prep.)	China Biscuit.
7 ,,	Oxide of Zinc	
5½ ,,	Flint	
¾ lb.	Phosphate of Soda	

10 **BLACK.**

1½ lbs.	Oxide of Cobalt (Black)	Earthenware Biscuit.
6¼ ,,	U.G. Black, No. 18	

11 **BLACK.**

4¼ lbs.	Oxide of Cobalt (Black)	Easy Earthenware Biscuit.
4¾ ,,	Oxide of Manganese	
2 ,,	Iron Scales	
½ lb.	Calcined Copper Turnings	

12 **MALACHITE GREEN.**

3 lbs.	Oxide of Cobalt (Prep.)	China Biscuit.
1¼ ,,	Oxide of Chrome	
9 ,,	Calcined Alumina	

13 **OLIVE GREEN.**

2½ lbs.	Chromate of Mercury	Earthenware Biscuit.
2¼ ,,	Oxide of Cobalt (Black)	
2½ ,,	Calcined Alumina	
1 lb.	Whiting	

14 **NAPOLEON GREEN.**

4¾ lbs.	Oxide of Chrome	China Biscuit.
3 „	Oxide of Cobalt (Prep.)	
1¼ „	Oxide of Zinc	
1½ „	Hydrate of Alumina	

15 **CHROME GREEN.**

4 lbs.	Oxide of Chrome	Easy Earthenware Glost.
¾ lb.	Oxide of Cobalt (Prep.)	
4¼ lbs.	Borax	
1½ „	Nitre	
1¼ „	Flint	

16 **PENCILLING BLUE.**

1¾ lbs.	Oxide of Cobalt (Prep.)	Earthenware Glost.
3¼ „	Oxide of Zinc	
1 lb.	Flint	
1¼ lbs.	Borax	
3¼ „	No. 8 Flux	

17 **BLUISH GREEN.**

4¼ lbs.	Oxide of Chrome	Earthenware Biscuit.
2¼ „	Oxide of Cobalt (Prep.)	
2 „	Oxide of Zinc	

18 **TURQUOISE.**

1 lb.	Oxide of Copper	Easy Earthenware Glost.
5½ lbs.	Flint	
4 „	Soda Ash	
6 ozs.	Pearl Ash	
6 „	Common Salt	

19 TURQUOISE.

1½ lbs.	Oxide of Copper	Easy Earthenware Glost.
5 ,,	Flint	
4¼ ,,	Soda Ash	
½ lb.	Nitre	

20 TURQUOISE.

1 lb.	Oxide of Copper	Easy Earthenware Glost.
4¾ lbs.	Flint	
2¾ ,,	Soda Ash	
1 lb.	Phosphate of Soda	
6 ozs.	Oxide of Tin	

21 TURQUOISE.

1 lb.	Oxide of Copper	Easy Earthenware Glost.
1¼ lbs.	Oxide of Tin	
2 ,,	Oxide of Zinc	
2 ,,	Flint	
3½ ,,	Felspar	
2 ,,	Red Lead	
1 lb.	Soda Ash	

22 ORANGE.

1½ lbs.	Oxide of Iron (Light)	Earthenware Glost.
4 ,,	Antimony Glass	
2½ ,,	Red Lead	
½ lb.	Umber	

23 YELLOW.

5 lbs.	Naples Yellow	Easy Earthenware Glost.
1 lb.	Oxide of Iron (Light)	
1¼ lbs.	Nitre	
3 ,,	Red Lead	

24 **GROUNDLAYING BLUE.**

2¾ lbs.	Oxide of Cobalt (Prep.)	Earthenware Glost.
2¼ ,,	Borax	
5 ,,	Flint	

25 **GROUNDLAYING MATT BLUE.**

1 lb.	Oxide of Cobalt (Prep.)	Earthenware Biscuit.
7 lbs.	Oxide of Zinc	
2¾ ,,	Barium Carbonate	
2¼ ,,	Flint	
1 lb.	Nitre	

ENAMEL COLOURS

1 **DEAD BLACK.**

1¼ lbs.	Oxide of Copper
11 ozs.	Blue Base, No. 4
11 ,,	Flux, No. 8

2 **BLACK.**

1¼ lbs.	Black Base, No. 10
1¾ ,,	Flux, No. 8

3 **BLACK.**

1 lb.	Black Base, No. 11
3 lbs.	Flux, No. 8

4 **GREENISH BLACK.**

1¼ lbs.	Oxide of Copper (Calcined)
3 ,,	Flux, No. 8

5 **BLACK.**

1 lb. Oxide of Copper
2 ozs. Oxide of Iron
1 lb. Flux, No. 8
2 lbs. Flux, No. 10

6 **SHINING BLACK.**

1¼ lbs. Blue Calx { 2 Cobalt. / 1 Red Lead
2¾ ,, Burnt Umber
1¼ ,, Flux, No. 8

7 **BLACK.**

1½ lbs. Oxide of Cobalt (Black)
¼ lb. Oxide of Manganese
4 lbs. Flux, No. 8

8 **RED BROWN.**

1¼ lbs. Brown Base, No. 1
3¼ ,, Flux, No. 2

9 **BROWN.**

1 lb. 2 ozs. Brown Base, No. 1
3¼ lbs. Flux, No. 8

10 **SEPIA BROWN.**

2½ lbs. Brown Base, No. 2
2¾ ,, Flux, No. 7

11 **DARK BROWN.**

1 lb. Burnt Umber
½ ,, Sienna
3½ lbs. Flux, No. 7

12 DARK BROWN.

$1\frac{1}{4}$ lbs. Oxide of Iron . . .
$2\frac{3}{4}$ „ Flux, No. 8
1 lb. Flux, No. 7. . . .

13 HAIR BROWN.

1 lb. Oxide of Manganese . .
$2\frac{3}{4}$ lbs. Flux, No. 8

14 BROWN.

$1\frac{1}{2}$ lbs. Crocus Martis . . .
$4\frac{1}{4}$ „ Flux, No. 8

15 BROWN.

1 lb. Burnt Sienna . . .
3 lbs. Flux, No. 8 . . .

16 TURQUOISE.

$1\frac{1}{2}$ lbs. Turquoise Base, No. 20 . .
$4\frac{1}{4}$ „ Flux, No. 4

17 TURQUOISE.

2 lbs. Turquoise Base, No. 21 . .
$5\frac{1}{2}$ „ Flux, No. 4

18 SKY BLUE.

1 lb. Blue Base, No. 8 . . .
4 lbs. Flux, No. 6 . . .

19 DARK BLUE.

2 lbs. Blue Base, No. 5 . . .
$5\frac{1}{2}$ „ Flux, No. 8

20 **GROUNDLAYING BLUE.**

2 lbs. Blue Base, No. 24 .
3¼ „ Flux, No. 11 .

21 **KING'S BLUE.**

1 lb. Blue Base, No. 4 .
3 lbs. Flux, No. 8 .

22 **GROUNDLAYING MATT BLUE.**

3 lbs. Blue Base, No. 25 .
4½ „ Flux, No. 8 .

23 **DARK BLUE.**

2½ lbs. Blue Base, No. 5 .
5 „ Flux, No. 7 .

24 **PENCILLING BLUE.**

2 lbs. Blue Base, No. 16 .
3 „ Flux, No. 8 .

25 **DARK BLUE.**

1¾ lbs. Smalt .
1¼ „ Red Lead .
5 „ Flint Glass .
¾ lb. White Enamel, No. 51 .

Glost Oven.

26 **BLUE.**

1½ lbs. Oxide of Cobalt (Prep.) .
1 lb. Oxide of Zinc .
1 „ Flux, No. 8 .
3½ lbs. Flux, No. 6 .

27 **YELLOW GREEN.**

2¼ lbs. Green Base, No. 12 .
½ lb. Yellow Base, No. 23 .
2½ lbs. Flux, No. 8 .

28 **NAPOLEON GREEN.**

2¼ lbs. Green Base, No. 14
5 „ Flux, No. 8

29 **STRONG GREEN.**

2 lbs. Green Base, No. 17
1 lb. Flux, No. 8

30 **GREEN.**

1 lb. Green Base, No. 15
3 lbs. Flux, No. 8

31 **BLUISH GREEN.**

2 lbs. Green Base, No. 17
7 „ Flux, No. 8

32 **OLIVE GREEN.**

1¼ lbs. Green Base, No. 13
1 lb. Orange, No. 39
½ „ Red Brown, No. 8

33 **PEA GREEN.**

2½ lbs. Green Base, No. 14
½ lb. Yellow Base, No. 23
1½ lbs. Flux, No. 5

34 **DRESDEN GREEN.**

1¾ lbs. Green Base, No. 17
1 lb. Oxide of Chrome
2¼ lbs. Flux, No. 8
1¾ „ Flux, No. 2

35 **MALACHITE GREEN.**

¾ lb. Green Base, No. 12
3½ lbs. Flux, No. 3

36 POMONA GREEN.

2 lbs. Oxide of Chrome . . .
3 „ Flux, No. 6
2 „ Flux, No. 1

37 YELLOW.

1 lb. Yellow Base, No. 23 . .
3 lbs. Flux, No. 8 . . .

38 AMBER.

1 lb. Orange Base, No. 22 . .
3 lbs. Flux, No. 10 . . .

39 ORANGE.

1 lb. Orange Base, No. 22 . .
2¾ lbs. Flux, No. 8

40 IVORY.

2 ozs. Orange Base, No. 22 . .
3¼ lbs. Flux, No. 8 . . .

41 AMBER.

½ lb. Oxide of Uranium . .
3½ lbs. Flux, No. 7

42 YELLOW.

½ lb. Oxide of Iron . . .
½ „ Oxide of Zinc . . .
1¾ lbs. Naples Yellow . . .
4½ „ Flux, No. 8 . . .

43 NASTURTIUM RED.

½ lb.	Bichromate of Potash	Hard Kiln.
3 lbs.	Red Lead	
1¼ „	Lead Nitrate	
½ lb.	Calcined Borax	
¾ „	Flint	

44 BRIGHT RED.

1 lb.	Red Chromate of Lead
3¾ lbs.	Flux, No. 9

45 ORANGE RED.

1 lb.	Colcothar
3 lbs.	Flux, No. 9

46 ORANGE RED.

1½ lbs.	Colcothar
1 lb.	Flux, No. 8
1 „	Flux, No. 9

47 RED.

1½ lbs.	Oxide of Iron (Light)
3½ „	Flux, No. 9

48 BRIGHT RED.

2½ lbs.	Flux, No. 1	Earthenware Glost.
2½ „	Enamel White, No. 51	
¼ lb.	Red Chromate of Lead	
5 lbs.	Base, No. 49	

49 **FINE RED.**

Mix together and pass through 40' lawn.

1½ lbs.	Ammonia Alum	Easy Hardening on Kiln.
1 lb.	Copperas	

Pound, wash with hot water and dry.

1 lb.	Base
3 lbs.	Flux, No. 9

50 **CORAL RED.**

1 lb.	Bichromate of Potash
1½ lbs.	Acetate of Lead

Dissolve separately in boiling water. Mix. A precipitate will form; this must be washed with hot water and dried.

1 lb.	Base
3 lbs.	Flux, No. 8

51 **WHITE ENAMEL.**

¾ lb.	Arsenious Oxide	Enamel Kiln.
5 lbs.	Flint Glass	
1½ ,,	Red Lead	
¼ lb.	Nitre	

52 **VELLUM.**

1¾ lbs.	Tin Ash	Hard Kiln.
2½ ,,	Red Lead	
2½ ,,	Flint	
¾ lb.	Borax	

53 **OPAQUE WHITE ENAMEL.**

1¾ lbs.	Arsenious Oxide	Hard Kiln.
2 ,,	Red Lead	
3¼ ,,	Flint Glass	
1 lb.	Borax	
1 ,,	Nitre	

54 OPAQUE WHITE ENAMEL.

1 lb.	Oxide of Tin	Earthenware Glost.
2½ lbs.	Stone	
2½ „	Borax	
1¾ „	Flint	

55 OPAQUE WHITE ENAMEL.

1½ lbs.	Oxide of Tin	Easy Earthenware Glost.
3 „	Flint	
1¾ „	Red Lead	
¾ lb.	Nitre	

56 CELESTE ENAMEL

½ lb.	White Enamel, No. 54	Easy Earthenware Glost.
1¾ lbs.	Oxide of Zinc	
1 lb.	Oxide of Copper	
1¾ lbs.	White Lead	
4 „	Borax	

57 RAISED PASTE.

1½ lbs.	White Enamel, No. 53
3½ „	U. G. Yellow, No. 80
¾ lb.	Enamel Yellow, No. 37

58 RAISED PASTE.

2½ lbs.	Enamel Base, No. 23
1 lb.	Tin Ash
2¼ lbs.	Enamel Base, No. 22
2 „	Flux, No. 8

59 ETCHING COLOUR.

1 lb.	Borax	Hard Kiln.
1 „	Flint Glass	
1 „	Flint	
3 lbs.	Litharge	

60 **DRAB.**

2 lbs. Enamel Blue, No. 19 . .
1¼ „ Enamel Green, No. 29 . .
3 „ Enamel Amber, No. 38 . .

61 **DISTANCE.**

1 lb. Enamel Black, No. 6 . .
¼ „ Enamel Orange, No. 39 . .
3 ozs. Enamel Rose. Page 139 . .
3 „ Enamel Purple. Page 139 .

62 **CELADON.**

1 lb. 2 ozs. Enamel Blue, No. 18 .
¾ „ Enamel Green, No. 29 . . .
3 lbs. Flux, No. 8

63 **LILAC.**

1¾ lbs. Enamel Blue, No. 18 . .
⅛ lb. Enamel Rose. Page 139. .
⅛ „ Enamel Purple. Page 139 .

64 **BROWN VELLUM.**

1¼ lbs. Oxide of Manganese . .
¼ lb. Tin Ash
3 lbs. Flux, No. 8

65 **RED VELLUM.**

1⅛ lbs. Bichromate of Potash . .
¾ lb. Lead Nitrate . . .
1¼ lbs. Red Lead Hard Kiln.
½ lb. Calcined Borax . . .
¼ „ Flint Glass

66 **GREEN VELLUM.**

1	lb. Enamel Yellow Base, No. 23	Hard Kiln.
⅝	,, Calcined Copper Turnings	
¼	,, Tin Ash	
1¼	lbs. Flint Glass	
¾	lb. Borax	
2¼	lbs. Red Lead	

67 **STRAW VELLUM.**

⅜	lb. Enamel Yellow, No. 42	Hard Kiln.
½	,, Tin Ash	
1	,, Borax	
3¼	lbs. Red Lead	
2½	,, Flint	

68 **OATMEAL VELLUM.**

¼	lb. Enamel Drab, No. 60	Hard Kiln.
⅝	,, Tin Ash	
1	,, Borax	
2½	lbs. Red Lead	
2	,, Flint	

69 **LIGHT PINK VELLUM.**

1	oz. Enamel Ruby	Hard Kiln.
½	lb. Enamel Orange, No. 39	
½	,, Tin Ash	
1	,, Borax	
2	lbs. Flint	
2	,, Red Lead	

70 OLD GOLD VELLUM.

¼ lb.	Enamel Orange, No. 39	Hard Kiln.
¼ „	Tin Ash	
½ „	Borax	
1¾ lbs.	Red Lead	
1½ „	Flint	

GOLD AND SILVER PREPARATIONS.

Special care has to be exercised during the manufacture of colours containing compounds of the rarer metals, since they are very susceptible to slight changes. The strength and proportion of the solvent acids, the admixture of bases with fluxes or diluents, and the grinding and mellowing operations are only variable within narrow limits. In fact, rigid adherence to such details may be said to be the main secret of success.

BROWN GOLD.

Pure metallic gold is dissolved in a minimum volume of *aqua regia* (3 parts hydrochloric and 1 part nitric acid). The solvent action may be facilitated by careful heating.

A filtered solution of ferrous sulphate is added to the prepared gold solution, and a flocculent precipitate is obtained. This is allowed to settle, the clear water is decanted off, and the residual gold precipitate is washed free from acid and dried.

MEDIUM BURNISH GOLD (Sand).

20 dwts.	Brown Gold	
10 „	Mercury	
1½ „	Chloride of Silver	
1 dwt.	Bismuth	

GREEN GOLD.

12 dwts. Green Gold
7½ ,, Mercury
1½ ,, Chloride of Silver
1½ ,, Gold Flux

PRINTING GOLD.

½ oz. Brown Gold
½ ,, Mercury
30 grs. No. 8 Flux

BURNISH SILVER.

2 ozs. Chloride of Silver
2 dwts. Bismuth

BRONZE GOLD.

2½ dwts. Brown Gold
1 dwt. Mercury
2 dwts. Oxide of Copper
¼ dwt. Gold Flux

CREST GOLD.

18 dwts. Brown Gold
10 ,, Mercury
3 ,, Chloride of Silver
5 grs. Bismuth

CHASING GOLD.

20 dwts. Brown Gold
14 ,, Mercury
1½ ,, Chloride of Silver
½ dwt. Bismuth
1 ,, No. 8 Flux

"PURPLE OF CASSIUS."

As great care is needed in the preparation of this important colour base, the various operations must be carefully carried out as described.

No. 1. Gold Solution.

1 dwt. of fine gold dissolved in 10 dwts. *aqua regia* (3 parts hydrochloric and 1 nitric acid).

No. 2. Tin Solution.

6 dwts. granulated tin dissolved in 30 dwts. *aqua regia* (2 parts hydrochloric and 1 nitric acid).

These two solutions must be filtered.

Pour into a large glass or porcelain vessel 3 pints of cold water, add the gold solution and mix thoroughly. Then run in solution No. 2 carefully, and stir constantly for ten minutes. Five pints of hot water must then be added and the stirring operation repeated.

After allowing the dilute solution to stand for several hours, when the purple precipitate will have completely subsided, the clear supernatant liquid can be siphoned off (and filtered) and the residual purple mass washed free from acid with hot water and *partially* dried for use.

By varying the relative proportions of the two metals gold and tin, tints other than purple are obtained, *e. g.* :

MARONE.

1 Gold : 4 Tin.

ROSE.

1 Gold : 5 Tin.

LIGHT PURPLE.

1 Gold : 10 Tin.

FLUXES.

The following mixtures must be fritted in flinted vessels in an easy earthenware glost oven.

ROSE.

6 lbs. Red Lead
5½ „ Flint
6½ „ Borax
2 „ Stone
1 lb. Nitre

MARONE.

6 lbs. Red Lead
2½ „ Flint Glass
8 „ Boracic Acid

RUBY.

2 lbs. Red Lead
5¼ „ Flint
9 „ Borax

PURPLE.

2 lbs. Red Lead
2¾ „ Flint
8 „ Borax

GOLD COLOURS.

MARONE.

Marone base, containing the equivalent of 1 dwt. gold.

16 grs. Carbonate of Silver
1 lb. Marone Flux

PURPLE.

Purple base, containing the equivalent of 1 dwt. gold.

1 dwt. Carbonate of Silver . .
4 ozs. Purple Flux . . .

RUBY.

Marone base, containing the equivalent of 1 dwt. gold.

6 grs. Carbonate of Silver . .
4 ozs. Ruby Flux

ROSE.

Rose base, containing the equivalent of 1 dwt. of gold.

12 grs. Carbonate of Silver . .
1 lb. Rose Flux

PINK.

Rose base, containing the equivalent of 1 dwt. of gold.

8 grs. Carbonate of Silver . .
½ lb. Purple Flux
½ lb. Rose Flux

ARABIAN SMOKED LUSTRES

1

100 parts Red Clay
35 „ Sulphide of Copper . .
12 „ Sulphide of Silver . .

2

100 parts China Clay
50 „ Sulphide of Copper . .

3

100 parts Calcined China Clay . .
30 „ Carbonate of Copper . .
2 „ Carbonate of Silver . .

4

100 parts Red Clay
25 „ Sulphide of Copper . .
1¼ „ Carbonate of Silver . .

The materials must be mixed, passed through a 100s lawn in the dry state, and made into a paste by the addition of a solution of ammonium oxalate, and then painted thinly and evenly over the glazed ware. A small percentage of tin oxide in the glaze enhances the brilliancy of the lustres. The firing is conducted in a normal manner until the interior of the kiln is just visibly red, after which reducing conditions must be produced without any further rise in temperature. This may be effected by introducing some form of carbonaceous matter, such as wood, resin, sawdust, leather, etc., or by admitting a stream of coal gas into the kiln. Another method consists in vaporising chlorides in the muffle. The main point to observe is, that the intensity of the reducing atmosphere is well under control, since the success of the process depends almost entirely upon correct firing conditions being maintained. The duration of the reducing period will vary according to the type of underlying glaze, thickness of paste, method of producing the reducing atmosphere, etc.

"BRIANCHON" LUSTRES.

Twenty parts of resin are melted in a porcelain dish on a sand bath until the mass becomes quiescent; six parts of bismuth nitrate are then added, the mixture being vigorously stirred. Stirring is repeated while thirty parts of lavender oil are added, and a further addition of twenty parts of the oil is required after the mixture has been partially cooled. This mixture will give a colourless lustre.

If the bismuth is replaced by an equivalent quantity of a

coloured metallic salt such as uranium or cadmium nitrate, cobalt sulphate, etc., the corresponding coloured lustres are produced. For cheaper colourless lustres, lead or zinc acetate may be substituted for the bismuth preparation.

Another method of producing metallic resinate lustres is sometimes adopted. The process may be best understood as consisting of three distinct operations :—

1. Fifty parts of resin, ten parts caustic soda, and twenty parts of water are heated together with constant stirring. A tough, brown resin soap is obtained when the mass is carefully cooled. If the resinate is stringy or porous it must be rejected.

2. Using this resin soap as a base, the metallic resinates are obtained by heating together 100 parts resin soap, 200 parts water, and 50 parts of a metallic salt, *e. g.* copper sulphate, lead acetate, uranium nitrate, etc.

3. The final operation consists in adding solvents to the metallic resinates. In some cases rosemary or lavender oil is used alone, while in others an addition of benzol is necessary. Typical recipes are appended.

A.	Copper Resinate	10
	Rosemary Oil	20
B.	Lead Resinate	10
	Rosemary Oil	20
	Benzol	3
C.	Uranium Resinate . . .	10
	Lavender Oil	20
	Benzol	3

GOLD LUSTRE.

Dissolve $\frac{1}{4}$ oz. of pure gold in a minimum volume of *aqua regia* (2 parts hydrochloric acid, 1 part nitric acid),

add 4 grs. of "grain" tin, heat gently to facilitate solution.

Mix 2½ ozs. balsam of sulphur and ½ pint best spirits of turpentine and heat until the balsam is completely dissolved. Add the gold-tin solution and stir the whole mass continuously for several hours. Age for three days before use.

PLATINUM LUSTRE.

Platinum is dissolved in a minimum volume of *aqua regia* (equal parts of hydrochloric and nitric acids); warm carefully, and add with constant stirring sufficient spirits of tar to give a workable liquid.

OILS, VARNISHES, ETC.

1 PRINTERS' OIL.

1 gall. Linseed Oil
1 qt. Rape Oil
2 ozs. Red Lead

Boil well together, and while cooling add

3 ozs. Sulphur
½ pt. Common Tar . . .

2 PRINTERS' OIL.

1 gall. Linseed Oil
1 oz. Red Lead
½ „ Resin (Pale)

Boil together, and while cooling add

½ pt. Common Tar . . .
½ „ Rape Oil

3 **PRINTERS' OIL.**

Boil well 1 gall Linseed Oil; then add slowly ¼ lb. Red Lead and ¼ lb. Gum Mastic previously melted together

4 **PRINTERS' OIL FOR GOLD PRINTING.**

1 gall. Linseed Oil
1 ,, Rape Oil
¼ lb. Canada Balsam . . .
¼ ,, Resin

All boiled together.

Printers' oil must be boiled until it ropes well; it also works better if aged before use.

PRINTERS' SIZE.

Always add one ounce of borax to each gallon of water used.

"HARDENING ON" SUBSTITUTE.

One part commercial concentrated sulphuric acid is diluted with 75 parts of water. The printed portions are sponged over with the solution, and the ware allowed to dry before being "dipped."

1 **GROUNDLAYING OIL.**

1 gall. Linseed Oil
1 ,, Turpentine
½ lb. Resin
¼ ,, Gum Mastic . . .

2 GROUNDLAYING OIL.

1 gall. Turpentine
1 pt. Linseed Oil
2 ozs. Resin
1 lb. Gum Mastic

3 GROUNDLAYING OIL.

1 gall. Linseed Oil
1 qt. Turpentine
2 ozs. Red Lead
2 „ Gum Mastic

Two hours' boiling is usually sufficient. Thin down with turpentine as required.

ADHESIVE FOR ENAMEL AEROGRAPHING COLOURS.

To prevent rubbing whilst standing in "receive" or during placing in the kiln, one teaspoonful of Canada balsam, dissolved in spirits of turpentine, may be added to each pint of prepared slop colour.

LITHOGRAPHING SIZE.

2 galls. Best Turpentine . . .
$4\frac{3}{4}$ lbs. Clear Resin
$\frac{1}{8}$ pt. Gold Size

Boil in a steam kettle with constant stirring. When dissolved, strain before using.

CHAPTER VIII

PRIME COST OF AN EARTHENWARE BODY AND GLAZE

BODY

THE following are some of the reasons why it is very difficult to lay down definite rules for calculating these costs :—

The recipes, raw materials, direct labour costs, and overhead charges vary at different works. Instances where one power unit is employed exclusively for the preparation of clay are rare. The boiler may be used to raise steam for heating purposes as well as for motive power. One engine may not only drive the sliphouse machinery, but also the air-pumps, fans, jiggers, etc.

In this chapter, therefore, the cost of raw materials only are dealt with, the correct amount to be added for capital outlay, power, labour, depreciation, etc., being left for the personal decision of the manufacturer.

WET MIXING

FORMULA OF BODY.

		Specific Gravity of dry material.
24 ins.	Ball Clay at 24 ozs. per pint . .	2·5
18 „	China Clay „ 26 „ „ . .	2·5
9 „	Flint „ 32 „ „ . .	2·5
4 „	Stone „ 32 „ „ . .	2·5

The size of the mixing ark is 5′ × 5′ × 6′ deep.

It is assumed that the slop flint and stone are bought from the miller at so much per slop peck of 32 lbs.

The percentages of hygroscopic water and knockings in the commercial clays are found to be—

	Hygroscopic water.	Knockings.
Ball Clay . . .	30 per cent.	3 per cent.
China Clay . .	10 ,, ,,	—

From these particulars the equivalent dry recipe may be calculated according to the instructions previously given.

Ball Clay :

$$\frac{60 \times 60 \times 24}{554{\cdot}55} = 155{\cdot}8 \text{ pecks.} \quad 155{\cdot}8 \times 6{\cdot}66 = 1037 \text{ lbs.}$$

China Clay :

$$\frac{60 \times 60 \times 18}{554{\cdot}55} = 116{\cdot}8 \text{ pecks.} \quad 116{\cdot}8 \times 10 = 1168 \text{ lbs.}$$

Flint :

$$\frac{60 \times 60 \times 9}{554{\cdot}55} = 58{\cdot}4 \text{ pecks.} \quad 58{\cdot}4 \times 20 = 1168 \text{ lbs.}$$

Stone :

$$\frac{60 \times 60 \times 4}{554{\cdot}55} = 25{\cdot}9 \text{ pecks.} \quad 25{\cdot}9 \times 20 = 518 \text{ lbs.}$$

The figures for the ball and china clays only represent theoretical approximations, consequently allowance must be made for the hygroscopic water and knockings, *e. g. :*

Ball Clay : with 30 per cent. hygroscopic water

As $70 : 100 :: 1037 : x = 1481$ lbs.

and 3 per cent. knockings.

As $97 : 100 :: 1481 : x = 1527$ lbs. Commercial ball clay.

China Clay : with 10 per cent. hygroscopic water

As $90 : 100 :: 1168 : x = 1297$ lbs. Commercial china clay.

Therefore 1527 lbs. of ball clay, 1297 lbs. of china clay, together with 58·4 pecks of flint and 25·9 pecks of stone give an equivalent mixing of the original recipe and would produce—

Ball Clay . .	1037 lbs.
China Clay . .	1168 ,,
Flint . . .	1168 ,,
Stone . . .	518 ,,
Or a total of .	3891 lbs. dry material.

Assuming the pugged clay to contain 26 per cent. water, then 3891 lbs. of dry material would give—

As 74 : 100 :: 3891 : x = 5258 lbs. of prepared clay.

This is yielded by—

	£	*s.*	*d.*
1527 lbs. Ball Clay at 65*s.* per ton . . .	2	4	3
1297 ,, China Clay ,, 98*s.* ,, . . .	2	16	8
58·4 pecks Flint ,, 1*s.* 4*d.* per peck . .	3	17	10
25·9 ,, Stone ,, 1*s.* 6*d.* ,, . .	1	18	10
	£10	17	7

So that the raw materials required to furnish 5258 lbs. of prepared clay will cost £10 17*s.* 7*d.*; 1 ton, therefore, costs £4 12*s.* 6*d.*

GLAZE

The manufacture of a pottery glaze consists of a series of distinct operations. Given the costs of these several stages, together with the prices of the materials used, the prime cost of any glaze can be calculated.

Each manufacturer will have to modify the figures to suit his own conditions. However, the general principles as set out below may be applied to ascertain the costs in connection with fritted glazes.

Earthenware Glaze.

Fritt.—196 lbs. Borax.
140 „ Stone.
112 „ Whiting.
140 „ Flint.
42 „ China Clay.

Total Batch 630 lbs.

Mill Mixing.

500 lbs. Fritt.
252 „ Stone.
140 „ White Lead.

What yield of fritt may be expected from the 630 lbs. batch?

Some glaze materials lose in weight during fritting. These losses are mainly due to the elimination of chemically combined water, and other gaseous products. Consideration of the chemical reactions involved enables the theoretical losses to be determined.

In practice, however, due allowance must be made for impure materials, loss of hygroscopic moisture, etc.

In the following table, the approximate theoretical losses are shown in percentages in column 1, and the estimated practical losses used for purposes of illustration are indicated in column 2.

	1.	2.
Boracic or Boric Acid	44	—
Pearl Ash	32	—
Soda Crystals	78	—
Red Lead	2	—
White Lead	14	—
Borax	47	47
Whiting	44	45
China Clay	14	16
Stone	—	5
Flint	—	6
Felspar	—	

With the figures in the above table as a basis, the following values are computed:

100 : 53 :: 196 : x = 104·0 Borax
100 : 95 :: 140 : x = 133·0 Stone.
100 : 55 :: 112 : x = 61·6 Whiting.
100 : 94 :: 140 : x = 131·6 Flint.
100 : 84 :: 42 : x = 35·3 China Clay.

465·5 lbs.

There are further minor losses, which would probably reduce the net weight of fritt to 460 lbs.

Summary of Costs of 460 lbs. of Fritt.

	£	*s.*	*d.*
1¾ cwts. Borax at 35*s.* per cwt.	3	1	3
1¼ ,, Stone ,, 7*s.* ,,		8	9
1 cwt. Whiting ,, 3*s.* ,,		3	0
1¼ cwts. Flint ,, 6*s.* ,,		7	6
⅜ cwt. China Clay ,, 4*s.* ,,		1	6
Cost of Materials	4	2	0
Assuming that—			
Labour costs are		7	6
Fuel ,, ,,		18	0
Repairs and Renewals		5	0
	£5	12	6

Then the total cost of the fritt is, therefore—

£5 12*s.* 6*d.* per 460 lbs.
or £1 7*s.* 4½*d.* „ cwt.
or £27 6*s.* 8*d.* „ ton.

Milling costs vary considerably; millers grinding for the trade often charge two distinct prices per score lbs.: one relating to the hard fritt, the other, a much lower rate, to the softer raw portion. In the following calculation an inclusive figure of 1*s.* 1*d.* per score has been taken.

SUMMARY OF GLAZE COSTS.

			£	*s.*	*d.*
500 lbs.	Fritt	at 27*s.* 4½*d.* per cwt. .	6	2	2
252 „	Stone	„ 7*s.* „ .		15	9
140 „	White Lead	„ 50*s.* „ .	3	2	6
892 „			10	0	5

GRINDING.

45 score lbs. at 1*s.* 1*d.* . . .	£2	8	9
Therefore, total cost of 900 lbs.* . .	£12	9	2

Cost per ton (exclusive of establishment charges) £31 0*s.* 2*d.*

* During the grinding operations a certain proportion of the grinding media, such as lining, runners, balls, etc., are always ground into the glaze, but as a partial offset, there is a smaller loss due to material left in the pan, to losses in sieving, etc. Assuming 18 lbs. gain and 10 lbs. loss, the net weight would be 900 lbs.

CHAPTER IX

FIRING CONTROL

FIRING

Of the many processes connected with the ceramic industry, that of firing is the most important. It is therefore imperative that the best methods by which this process may be regulated and controlled should be adopted.

The thermal phenomena commonly used for this purpose are—

(1) Contraction of specially prepared bodies.
(2) Increase in density and "ring."
(3) The development of translucency.
(4) The maturing of glazes.
(5) Colour changes.
(6) Softening of fusible silicate-pyroscopes.
(7) Electrical pyrometers.
(8) Optical pyrometers.

The complex reactions that take place in pottery bodies and glazes during firing, are the result of both time and temperature; that is to say, the result achieved, when the oven is fired a certain number of hours to a definite maximum temperature, can be duplicated by firing at a lower temperature for a longer period of time.*

Naturally, then, firing control systems, or "firing trials," based on this principle, are of the utmost value. Notwithstanding the utility of the foregoing trials, it should be remembered that important changes take place at temperatures much below that at which any indications are given, other than by an electrical pyrometer. As a result their use has become increasingly popular, and they are, without doubt, a valuable asset to any factory.

The contraction which takes place when clay or pottery bodies are fired, forms the basis of various "contraction

* Of course, this only applies when the extra time is taken during the later stages of the firing, after incipient fusion has taken place in at least one portion of the mixture.

pyrometers " : " Wedgwood's Bits " and " Buller's Rings " are perhaps the best known of this type ; the introduction of the latter has given the contraction trial method a decided impetus, since some of the obvious disadvantages of the earlier types have been overcome. In both systems the results can be readily tabulated and systematically recorded. Many manufacturers do not take full advantage of the method, inasmuch, that if the fireman fires the oven, until the rings or bits have reached a certain standard, they are satisfied. The reviewer suggests that if the practice (already used on isolated factories) of working to a prearranged firing curve (based on a graph where hours of firing are plotted against number of ring or bit) were adopted generally, better results would follow.

The fusible pyroscopes are compounded of materials similar in composition to those of bodies and glazes, and, as might be expected, their firing behaviour is analogous to that of the actual ware. They are measurers of " heat work " and, as in the case of " contraction degrees," do not indicate actual temperatures.

In condensing the previous remarks, it will be seen that good and consistent results can be obtained by the use of continuous recording pyrometers, used in conjunction with contraction or fusible pyroscopes, and also some form of " trial " which will show when the ware has attained its own particular characteristic, *e. g. :*

Bone China : Translucency.
Hotel Ware : Density.
Earthenware : Density.
Tiles : Density.
Enamelled Fireclay : Development of enamel.
General Glost Ovens : Maturing of glaze.
Enamel Kiln : Development of Rose colour.

It is essential for the correct firing of certain types of pottery, that the atmosphere inside the oven be oxidizing ;

e. g. Bone China needs a considerable volume of excess air to burn off the various forms of carbonaceous matter; on the other hand, the finest hard porcelain is produced in ovens in which, at certain periods, reducing conditions prevail; other ceramic products may require a neutral atmosphere. However, in every case, excess air passed through an oven above the amount required to produce first-class goods results in the loss of heat units.

To ensure that proper conditions are maintained, frequent analyses of the waste gases entering the hovel are required. Automatic Carbon Dioxide Recorders furnish this information and, if used intelligently, will assist in the production of the maximum percentage of best goods from the consumption of a minimum amount of fuel.

FUSIBLE PYROSCOPES

CALORITES.

The following are mostly used in the Potting trade :—

Approximate Temperature of Fusibility. Degrees Centigrade	Calorite No.	Colour at end of Calorite.	SUITABLE FOR
500	CT 19	Grey	
580	CT 18	White	Reducing Flambé Colours.
590	CT 1	Red	Flint Glass Colours.
650	CT 2	Yellow	Cathedral Glass Colours.
800	CT 3	Pink	Enamel Colours.
890	CT 4	Dark Blue	Soft Majolica Glazes.
950	CT 5	Mauve	Majolica Glazes.
1050	CT 6	Yellow Brown	Earthenware Glazes.
1090	CT 7	Light Green	Low Earthenware Biscuit and Hard Glazes.
1150	CT 15	Red Tipped Ivory	Hard Earthenware Biscuit.
1190	CT 16	Marine Green	Sèvres Soft Paste Biscuit.
1230	CT 17	Blue Green	Vitreous Hotel Ware Biscuit.
1270	CT 9	Dark Green	Hard Earthenware Biscuit and Fusibility of Felspar.
1290	CT 10	Light Blue	Granite Biscuit and Fusibility of Cornwall Stone.
1310	CT 11	Violet	Soft Commercial Continental Porcelain.
1330	CT 12	Buff	China Biscuit.
1370	CT 13	Black Brown	German Porcelain.
1470	CT 14	Blue Black	Porcelain.

REVISED LIST OF APPROXIMATE BENDING TEMPERATURES OF HOLDCROFT'S THERMOSCOPE BARS.

Bar No.	Degrees. Centigrade	Bar No.	Degrees. Centigrade	Bar No.	Degrees. Centigrade	Bar No.	Degrees. Centigrade
1	600	11	890	22	1080	31	1350
2	650	12	905	23	1100	32	1380
3	670	13	920	24	1120	33	1430
4	700	14	935	25	1140	34	1460
5	730	15	950	26	1200	35	1475
6	760	16	960	26a	1230	36	1490
7	790	17	970	27	1250	37	1505
7a	810	18	985	27a	1270	38	1520
8	840	19	1000	28	1280	39	1535
9	860	20	1040	29	1300	40	1550
10	875	21	1060	30	1325		

THE HORSFALL PATENT MELTING PYROMETER.

No.	Melting Metals.		No.	Melting Metals.		No.	Melting Metals.		No.	Melting Metals.	
	F.	C.		F.	C.		F.	C.		F.	C.
1	1980°	1082°	5	1560°	849°	9	1040°	560°	13	619°	326°
2	1886°	1030°	6	1434°	780°	10	950°	510°	14	515°	268°
3	1859°	1015°	7	1283°	695°	11	784°	418°	15	449°	232°
4	1643°	895°	8	1175°	635°	12	770°	410°	16	392°	200°

WATKINS PATENT HEAT RECORDERS.

Approximate Temperatures of the Recorders. Revised.

No.	Cent.	Fahr.	No.	Cent.	Fahr.
1	**600**	**1112**	**31**	**1280**	**2336**
2	650	1202	32	1300	2372
3	**670**	**1238**	**33**	**1320**	**2408**
4	690	1274	34	1350	2462
5	**710**	**1310**	**35**	**1380**	**2516**
6	730	1346	36	1410	2570
7	**750**	**1382**	**37**	**1435**	**2615**
8	790	1454	38	1460	2660
9	**815**	**1499**	**39**	**1480**	**2696**
10	835	1535	40	1500	2732
11	**855**	**1571**	**41**	**1520**	**2768**
12	880	1616	42	1530	2786
13	**900**	**1652**	**43**	**1580**	**2876**
14	920	1688	44	1610	2930
15	**940**	**1724**	**45**	**1630**	**2966**
16	960	1760	46	1650	3002
17	**980**	**1796**	**47**	**1670**	**3038**
18	1000	1832	48	1690	3074
19	**1020**	**1868**	**49**	**1710**	**3110**
20	1040	1904	50	1730	3146
21	**1060**	**1940**	**51**	**1750**	**3182**
22	1080	1976	52	1770	3218
23	**1100**	**2012**	**53**	**1790**	**3254**
24	1120	2048	54	1825	3317
25	**1140**	**2084**	**55**	**1850**	**3362**
26	1160	2120	56	1880	3416
27	**1180**	**2156**	**57**	**1920**	**3488**
28	1200	2192	58	1960	3560
29	**1230**	**2246**	**59**	**2000**	**3632**
30	1250	2282			

Series of Recorders most suitable for different classes of Ovens and Kilns.

A	1	3	5	7	9	Enamel Kiln.
	3	5	7	9	11	,, ,,
	5	7	9	11	13	Hard Kiln for Marones, etc.
	7	9	11	13	15	,, ,, ,,
	9	11	13	15	17	(Soft) Glaze Kiln for Tiles, etc.
B	11	13	15	17	19	(Hard) Glaze Kiln ,, ,,
	13	15	17	19	21	(Easy) Glost Oven and Rockingham.
	15	17	19	21	23	(Hard) ,,
	17	19	21.	23	25	Earthenware Biscuit Oven.
	19	21	23	25	27	Hard ,, ,, ,,
C	21	23	25	27	29	Tile Biscuit and Granite Biscuit.
	23	25	27	29	31	Parian Biscuit and Glazed Bricks.
	25	27	29	31	33	China Biscuit and Salt Glaze.
	27	29	31	33	35	,, ,,
	29	31	33	35	37	Hard Paste Porcelain.
D	31	33	35	37	39	Hard Paste Porcelain.
	33	35	37	39	41	Refractory Products.
	35	37	39	41	43	
	37	39	41	43	45	
	39	41	43	45	47	
E	41	43	45	47	49	Research Work.
	43	45	47	49	51	
	45	47	49	51	53	
	47	49	51	53	55	
	49	51	53	55	57	
F	51	53	55	57	59	Research Work

APPROXIMATE SQUATTING TEMPERATURES OF SEGER CONES.

Cone No.	Cent.	Fahr.	Cone No.	Cent.	Fahr.	Cone No.	Cent.	Fahr.	Cone No.	Cent.	Fahr.
022	600	1112	07a	960	1760	9	1280	2336	29	1650	3002
021	650	1202	06a	980	1796	10	1300	2372	30	1670	3038
020	670	1238	05a	1000	1832	11	1320	2408	31	1690	3074
019	690	1274	04a	1020	1868	12	1350	2462	32	1710	3110
018	710	1310	03a	1040	1904	13	1380	2516	33	1730	3146
017	730	1346	02a	1060	1940	14	1410	2570	34	1750	3182
016	750	1382	01a	1080	1976	15	1435	2615	35	1770	3218
015a	790	1454	1a	1100	2012	16	1460	2660	36	1790	3254
014a	815	1499	2a	1120	2048	17	1480	2696	37	1825	3317
013a	835	1535	3a	1140	2084	18	1500	2732	38	1850	3362
012a	855	1571	4a	1160	2120	19	1520	2768	39	1880	3416
011a	880	1616	5a	1180	2156	20	1530	2786	40	1920	3488
010a	900	1652	6a	1200	2192	26	1580	2876	41	1960	3560
09a	920	1688	7	1230	2246	27	1610	2930	42	2000	3632
08a	940	1724	8	1250	2282	28	1630	2966			

In a general way the following list shows the Cones usually employed in the regular types of oven and kiln :—

Enamel Kiln (soft Fluxes)	022 to 019a
„ „ (ordinary)	020 „ 014a
„ „ (hard)	016 „ 010a
Red Brick Kiln	015a „ 01a
Tile and Majolica Kilns	010a „ 01a
Glost Oven (soft glazes, Rockingham)	07a „ 01a
„ „ (Earthenware and China)	05a „ 03a
Earthenware Biscuit Oven	01a „ 5a
Vitreous Tile and Granite Biscuit Oven	3a „ 8
Parian Oven	01a „ 9
China Biscuit and Sanitary Ovens	7 „ 11
Hard Porcelain	12 „ 16

TEMPERATURE CALCULATIONS.

°F to °C $C = \frac{5}{9}(F - 32)$

°C to °F $F = \frac{9C}{5} + 32$

CHAPTER X

CHEMICAL AND PHYSICAL TESTS

THE necessity of systematically testing the raw materials used in the manufacture and decoration of pottery, both with regard to their purity and moisture content, has been dealt with on pages 1, 29, 62 and 96.

It may now be explained that the tests employed in determining the above factors are either physical or chemical; that is to say, the physical properties of the material may be examined by empirical methods, or its actual composition may be ascertained by chemical analysis. There is no doubt that the success of a technician depends upon his ability to combine and correlate the information furnished by both methods. It is therefore important that the testing of the various materials should be efficiently and systematically carried out, so that definite conclusions may be readily deduced.

SAMPLES TAKEN FOR TESTING PURPOSES.

It is of the utmost importance that fully representative samples of the whole consignment be taken for testing purposes.

CHEMICAL ANALYSIS.

The analysis of body materials, colours, glazes, etc., is an operation that requires not only specialized training in silicate analysis, but also the necessary apparatus and reagents. As the latter are not usually available in works

laboratories, it is advisable to have complex analyses of this nature carried out at one of the public institutions that make a speciality of this class of work.

In a practical book such as the Manual, it is not considered advisable to include the analytical methods involved in a chemical analysis, since there are a number of excellent text-books already available, notable among which is Dr. Mellor's *Treatise on Quantitative Inorganic Chemistry.*

Many useful tests, however, *e. g.* Percentage of Lime in Flint, Purity of Red and White Lead, Purity of Borax, etc., can readily be made " on the works " without needing elaborate apparatus. We are indebted to Mr. H. V. Thompson, M.A., for permission to include the following " Spot tests," which are taken from his useful booklet, *The Analysis of Clays, Potter's Materials and Pottery ' Spot ' Tests.*"

POTTERY "SPOT" TESTS.

The following scheme, which makes no claim to be exhaustive, indicates the methods whereby a number of the more important materials, used in the Pottery Industry, can be detected and identified by the ordinary dry tests used in qualitative analysis.

A. White Substance Soluble in Water

(1) *Alum.*—Neutral solution: heated on charcoal with cobalt nitrate a blue mass is given.

(2) *Boric Acid.*—Solution acidic towards phenolphthalein: green borate flame on ignition in evaporating dish with concentrated sulphuric acid and alcohol.

(3) *Calcined Borax.*—(Somewhat insoluble in water.) Alkaline solution: yellow sodium flame: green borate flame as above.

(4) *Potassium Carbonate.*—Violet potassium flame: alkaline solution which evolves carbon dioxide on acidifying with dilute hydrochloric acid.

(5) *Potassium Nitrate.*—Violet potassium flame: neutral solution. Add a few ccs. of ferrous sulphate to the solution and pour in cautiously concentrated sulphuric acid—a brown ring where the two liquids meet.

(6) *Salt.*—Neutral solution: yellow sodium flame: the solution acidified with nitric acid give a precipitate with silver nitrate, soluble in excess of ammonia.

(7) *Sodium Carbonate.*—Yellow sodium flame: see also No. 4.

B. Yellowish-Red Substance Soluble in Water

Potassium Dichromate.—Violet potassium flame: neutral solution. Acidify the solution with dilute sulphuric acid, add a few ccs. of ether, followed by a few ccs. of hydrogen peroxide—a blue colour soluble in ether.

C. White Substance Soluble in Dilute Hydrochloric Acid with Effervescence and Evolution of Carbon Dioxide (detected by action on lime water)

(1) *Whiting.*—Orange calcium flame.

(2) *Barium Carbonate.*—Apple green flame.

(3) *Magnesium Carbonate.*—Pinkish mass on heating with cobalt nitrate on charcoal.

(4) *White Lead.*—The solution in aqueous hydrochloric acid on cooling deposits crystals of lead chloride: lead bead by reduction on charcoal with sodium carbonate.

D. Coloured or Black Substance

Heat on charcoal with sodium carbonate: if a lead bead is given the substance may be—

(1) *Galena.*—Black: dissolves in concentrated hydrochloric acid with evolution of hydrogen sulphide (detected by smell and black stain on lead acetate paper).

(2) *Lead Chromate.*—Dissolve in moderately concentrated sulphuric acid. Cool the solution, filter off the lead sulphate

and apply the hydrogen peroxide-ether test to the filtrate (for which see B, Potassium Dichromate).

(3) *Lead Oxides.*—Yellowish to brown if as litharge (do not confuse with iron oxide); red if as red lead.

(4) *Naples Yellow.*—Yellow: very heavy substance. If no lead bead is given on charcoal try the borax bead.

(*a*) Blue bead	*Cobalt*	probably	as oxide.
(*b*) Bead green hot, blue cold	*Copper*	,,	,,
(*c*) Yellowish bead . .	*Iron*	,,	,,
(*d*) *Violet bead . . .	*Manganese*	,,	,,
(*e*) *Brownish-violet bead .	*Nickel*	,,	,,

* Distinguish by fusion on platinum foil with sodium carbonate and potassium nitrate—manganese alone gives a greenish mass.

E. White Substance perhaps Soluble in Hydrochloric Acid without Effervescence

(Try both dilute and concentrated acids.)

(1) *Alumina.*—Blue residue on heating on charcoal with cobalt nitrate.

(2) *Barium Sulphate.*—Inappreciably soluble in concentrated acid. Green barium flame.

(3) *Bone Ash.*—Orange calcium flame: blue residue on charcoal as with alumina. Bone ash dissolved in excess of nitric acid and warmed with ammonium molybdate gives a yellow precipitate.

(4) *Borocalcite.*—Orange calcium flame: green borate flame.

(5) *Fluorspar.*—Orange calcium flame: heat with a little concentrated sulphuric acid in a lead dish on a sand bath—white fumes are given off which deposit gelatinous silica on a wet glass rod held in them.

(6) *Lead Borate.*—Lead bead on charcoal: borate flame. *Lead Silicate.*—Lead bead on charcoal: decomposed on

boiling with concentrated hydrochloric acid giving lead chloride and silica.

(7) *Magnesia.*—See C (3).

(8) *Plaster of Paris.*—Orange calcium flame: "sets" with water.

(9) *Tin Oxide.*—Malleable bead on reduction on charcoal: dirty-bluish green mass with cobalt nitrate.

(10) *Zinc Oxide.*—Heat on charcoal the residue is yellow when hot, white when cold: with cobalt nitrate a green residue is given.

NOTE.—*China Clay, Cornish Stone, Felspar and Flint* can be best identified by physical tests. Flint, however, on evaporation with hydrofluoric acid in a platinum dish leaves no residue which distinguishes it from the other three substances.—H. V. THOMPSON.

Another reliable and rapid method of distinguishing between flint and Cornish Stone (not Jersey) is to slop up the two samples with water and pass through a silk lawn, say 200s. Residue from the stone always contains small particles of mica.

To show the importance of supplementing the information derived from a chemical analysis, by that obtained by physical tests, the following typical analyses are appended.

	Ball clay.	China clay.	Dry white stone.	Earthenware pitchers.
SiO_2	49·85	47·33	74·96	75·58
TiO_2	0·96	—	0·30	0·21
Al_2O_3	32·95	38·72	16·20	18·40
Fe_2O_3	1·21	0·55	1·20	0·58
MgO	0·43	0·13	0·33	0·25
CaO	0·58	0·31	1·67	1·56
K_2O	3·41	1·08	4·31	1·76
Na_2O	0·88	0·22	0·45	0·91
Loss	9·86	12·20	1·13	0·96

From the similarity in composition of the Ball clay and China clay, it can be readily understood that the main differences between these two clays must be in their physical properties.

For reference to stone and pitchers, see remarks on Cornish stone, page 163.

PHYSICAL TESTS.

Clays.—Owing to the varied conditions under which clays are used, and to the fact that the methods of conducting certain of the tests have not been standardized, it is difficult to give definite rules of procedure. As a consequence, the technician has to design a test which will give him comparative or relative values, which values must be reducible to figures. It is desirable, however, in practically all cases, to collect the following data : Plasticity, Tenacity, Uniformity of Texture, Drying contraction, Warping during drying, Firing contraction, Porosity, Colour after firing, and Glazing properties. The four latter tests should be carried out with samples fired at the various temperatures such as are likely to be met with in practice.

For general remarks on *Grinding*, see page 18.

Flint.—The two most important items that need attention are—

(1) The presence of lime.
(2) The degree of calcination.

(1) The presence of abnormal quantities of lime in ground flint is liable to cause " crazing," not due to the presence of the lime, but to the fact that it has displaced flint, which is an anti-crazing material.

(2) On page 9 a number of calculations are given showing how the dry content of slop flint varies with the degree

of calcination. Consequently it can readily be seen why it is advisable to occasionally determine the specific gravity by means of the relative density bottle.

After firing in a China biscuit oven, flint should show no indication of sintering, and possess a good colour.

Cornish Stone.—This material is often adulterated with earthenware pitchers. By reference to the analyses on page 161, it can be seen that if only moderate amounts of pitchers are added detection is exceedingly difficult.

The fusibility of Cornish stone is dependent upon the particular type, according to whether it be "hard purple," "dry white," "mixed," etc. An average sample passed through a China biscuit oven should partially melt to a white, opaque, semi-vitreous mass. Any tendency towards "bloating" when hard-fired should be noted.

Felspar.—When fired in a China biscuit oven, a good sample of felspar should completely fuse to a white semi-translucent mass. A mixture consisting of 92 per cent. Potash Felspar and 8 per cent. Whiting has a much lower melting-point than the felspar alone, consequently this material is often added as an adulterant, but its presence may be readily detected by means of a chemical analysis.

Whiting.—After firing in the biscuit oven certain brands of whiting exhibit a blue coloration; these brands should be rejected.

Bone Ash.—Apart from the Phosphate content and loss in weight during firing, the plasticity of bone ash is most important. For this reason all burnt bone should be rejected. Colour, contraction, and porosity are other factors needing consideration. It is important that all bone trials should be bedded, and not placed and fired in open setters as is usually the case.

TREATMENT OF TRIALS.

In all cases the trials of the various materials should have similar firing treatment as the materials in bulk are likely to receive in actual practice.

PLACING SAND.

Brown specked ware, due to impure sand, is intensified if either the sand or the ware is damp when placed in the oven. When testing new supplies of placing sand, it is therefore advisable to use the sand damp, and to have the clay ware " hard green." The ware should be " bedded," and fired in a good sound saggar.

The " packing " or " caking " of placing sand is best avoided by the elimination of the finer particles, since it is these that prevent the sand from remaining in an easily mobile condition, so as to be free to move with the contracting ware.

CRAZING TESTS FOR DOMESTIC GOODS.

(A) The test pieces should be boiled for an hour in a strong brine solution, then taken out, and immersed in cold water; this process of heating and rapid cooling being repeated until crazing appears.* The strength of the brine solution and the method of quenching must be standardized to ensure concordant results.

(B) A steam kettle is fitted with two pipes through one of which steam can be admitted at a constant pressure, the other being connected to the water main. The trial pieces are placed in the kettle and subjected to the influence of the steam for several hours. They are then suddenly cooled by shutting off the steam and turning on the water.*

* The relative soundness of the test-pieces is indicated by the number of times that they withstand the alternate heatings and coolings.

An alternate method, which is sometimes preferred, is that of submitting the trials to the prolonged influence of steam under pressure, and then allowing them to cool gradually, in place of the quick cooling by means of the cold water.*

TEST FOR ENAMELLED FIRECLAY AND GLAZED BRICKS.

The sample selected for testing should have at least one unglazed surface. It must be boiled for an hour in a saturated solution of sodium thiosulphate, and afterwards allowed to stand in a cool place for several hours. This treatment should be repeated until the engobe and the glaze are ruptured.*

The test is an excellent one to determine the suitability of this class of goods for use in exposed positions.

THE HEATING VALUE OF COAL, ETC.

It is advisable to check periodically the heating value of the coal supplied, though it must be remembered that other physical properties, such as length of flame, temperature of distillation, type of ash, etc., have an important bearing on the question of the suitability of a particular fuel. Anthracite coal, for instance, has a much higher calorific value than the bituminous variety; yet for direct firing of pottery it is not so suitable as the latter type.

The heating power or calorific value of a fuel is determined by the quantity of heat generated by unit weight or volume (grammes, lbs., cubic feet, etc.) when combusted under perfect conditions. These several units naturally lead to the introduction of various thermal values, of which the most commonly recognised are: the gramme calorie, the lb. calorie, and the British Thermal Unit (B.T.U.).

* The relative soundness of the test-pieces is indicated by the number of times that they withstand the alternate heatings and coolings.

The amount of heat required to raise the temperature of—

1 pound of water 1°F = 1 B.T.U.
1 ,, ,, ,, 1°C = 1 lb. cal.
1 gramme of water 1°C = 1 gram. cal.

1 lb. cal. = 1·80 B.T.U.
1 B.T.U. = 0·55 lb. cal.

The calorific value of solid fuels may be accurately determined by direct calorimetric methods, or where the ultimate chemical composition is known an approximate value may be obtained by calculation, for which purpose certain formulæ are used.

Though the general principle that " the calorific value of a fuel is equal to the sum of the calorific values of its constituents " is recognised, many modifications mainly concerned with certain complex reactions which occur during combustion are used. For coal, coke, etc., the simplified formula indicated below gives results closely approximate to those obtained by direct calorimetric determinations.

Formula for the calculation of calorific value from the ultimate analysis.

$$81\,C + 345\left(H - \frac{O + N - 1}{8}\right) + 22\,S = \text{lb. cals.}$$

For example, analyses of two typical coals are here given.

	Bituminous.	Anthracite.
Carbon	78·6	93·4
Hydrogen	5·8	2·5
Sulphur	1·3	0·3
Oxygen	6·5	1·4
Nitrogen	1·7	1·2
Water	2·8	1·1
Ash	3·5	0·5

To ascertain the calorific value of the bituminous coal.

$$(81 \times 78{\cdot}6) + 345\left(5{\cdot}8 - \frac{6{\cdot}5 + 1{\cdot}7 - 1}{8}\right) + (22 \times 1{\cdot}3) =$$

$$6366{\cdot}6 + (345 \times 4{\cdot}9) + 28{\cdot}6 = 6366{\cdot}6 + 1690{\cdot}5 + 28{\cdot}6 =$$

8085·7 lb. cals. or 14,554 B.T.U.

Similarly the anthracite is found to have a calorific value of—

8365·5 lb. cals or 15,058 B.T.U.

Table of Average Calorific Values of Fuels

Petrol	20,200	B.T.U. per lb.
Light Candle Oil	20,600	,, ,, ,,
Petroleum	19,880	,, ,, ,,
Bituminous Coal	14,700	,, ,, ,,
Anthracite Coal	15,500	,, ,, ,,
Coal Gas	400–550	B.T.U. per cubic foot
Coke Oven Gas	380–420	,, ,, ,, ,,
Suction Producer Gas	140–190	,, ,, ,, ,,

APPENDIX

GRINDING CYLINDERS.

THE undermentioned are the principal factors influencing the mechanical efficiency of grinding cylinders.

(1) Nature of lining (whether rough, smooth, hard, etc.).

(2) Nature of the material being ground.

(3) The relative proportions of pebbles, water, and material being ground.

(4) The size of the pebbles.

(5) The speed of rotation of the cylinder.

(6) The duration of grinding.

On consideration of the above, it will be seen that reliable tables, giving particulars of speed, horse-power, etc., can only be the average of many results taken over an extended period. As a consequence such tables will need modification to suit specific cases. It is advisable to have in use a revolution meter, so that the total number of revolutions made, during any run, are automatically recorded.

TABLE FOR FLINT GRINDING

Outside diameter of cylinder.	Revolutions per minute.	Approx. H.P.	Weight of charge in cwts.	Weight of pebbles in cwts.
7′ 0″	19	15–20	45	80
6′ 0″	24	9½–15	29	50
5′ 6″	26	7–12	21	37
4′ 6″	32	4–6½	11	20
3′ 0″	42	2–3½	3½	6

STANDARDIZATION OF SLOP WEIGHTS.

(A) Reduction of weight per pint by the addition of water. This is calculated as follows:

(1) The desired weight per pint, in ozs., is deducted from the corresponding figure of the heavier slop material.

(2) Subtract 20 from the required pint weight in ozs.

The two numbers so obtained indicate the respective volumes of water and slop material.

Example.—A glaze weighing 34 ozs. per pint has to be diluted to weigh 32 ozs. per pint:

$$\begin{aligned} (1) \quad & 34 - 32 = 2 \\ (2) \quad & 32 - 20 = 12 \end{aligned}$$

so that two pints of water must be added to every 12 pints of glaze.

(B) To mix two slips of different weights per pint, so as to give a slop material having a weight per pint intermediate between the two.

This is a simple calculation, as may be seen from the following example:

From two slop *materials*, the weights of which are 32 ozs. and 28 ozs. per pint respectively, it is desired to produce one weighing 29 ozs. per pint.

Obviously, more of the slop at 28 ozs. will be required than that at 32 ozs. The necessary proportions of each will therefore be—

$$\left.\begin{aligned} 32 - 29 &= 3 \text{ pints at 28 ozs.} \\ 29 - 28 &= 1 \text{ pint at 32 ozs.} \end{aligned}\right\} = 4 \text{ pints at 29 ozs. per pint.}$$

MOULDMAKERS' SIZE.

The addition of a teaspoonful of glycerine to each quart of size will facilitate the delivery of moulds from the cases, and also prevent the pores of the sponges from clogging.

ANTI-SET FOR GROUND FELSPAR, Etc.

For this purpose $1\frac{3}{4}$ lbs. of Epsom salts per ton of material will be found effective.

ANTI-SET FOR GLAZES.

To each ton of glaze add 1 lb. of calcium nitrate.

PRESS OIL.

A mixture of equal parts of paraffin oil and rape oil gives the best results both for dust-pressed and semi-plastic goods.

RECOVERY OF GOLD FROM GILDER'S WASTE.

All bottles, palettes, etc. should be washed out with turpentine. The rags and papers should also be collected and carefully burned, the rinsings from the bottles, etc. being added, if desired, during the incineration.

The residual ash must be mixed with a flux and an oxidizing agent in the following proportions: Ash 4 parts, calcined borax 4 parts, and nitre 1 part. The actual smelting operation may be carried out in various ways, but either of the following methods will give satisfactory results.

(1) A thickly-flinted fireclay crucible is 3 parts filled with a mixture made up of 4 parts of borax and 1 of nitre. A hole is made in the centre of this mixture and the residual ash which has been previously and intimately mixed with borax and nitre in the proportions mentioned above, is introduced into the cavity. The mass is covered with a layer of common salt about half an inch in depth, and the crucible fired in the bottom saggar in the fore-bung of an earthenware biscuit oven.

(2) The residual ash may be mixed with the fluxes and put into a thickly flinted crucible, covered with salt and fired as in the preceding method.

CONVERSION DATA.

LENGTH.

1 inch = ·0833 ft. = ·0278 yd. = ·0254 metre.
1 foot = ·0001894 mile = ·3048 metre.
1 yard = ·000568 mile = ·9144 metre.
1 mile = 63,360 inches = 5280 ft. = 1609·315 metres.
1 metre = 3·281 feet = 39·370 inches.
1 kilometre = ·62138 mile.
1 millimetre = $\frac{1}{25}$ of an inch (approx.).

WEIGHT.

1 lb. avoirdupois = ·00893 cwt. = 453·57 grammes.
1 cwt. = 50,802 grammes.
1 ton = 1,016,048 grammes.
1 kilogramme = 2·2046 lbs.
1 lb. of water = 27·72 cubic inches = ·10 gallon = ·4537 kilo.
1 cwt. „ = 11·2 gallons = 1·8 cubic feet.
1 ton „ = 35·9 cub. ft. = 224 galls. = 1000 litres (approx.).
= 1 cub. metre (approx.).
1 cubic foot of air = ·0809 lb. @ 32° F.
1 litre of air @ 32° F. = 1·2932 grammes.

SURFACE.

1 sq. inch = ·00694 sq. ft. = ·00077 sq. yd. = ·000645 sq. metre.
1 sq. foot = ·111 sq. yd. = ·0929 sq. metre.
1 sq. yard = 1296 sq. ins. = ·8361 sq. metre.
1 sq. cm. = ·155 sq. in.
1 sq. metre = 10·7639 sq. ft. = 1·196 sq. yds.

ENERGY AND WORK.

1 foot lb. = 778 British Thermal Units (B.T.U.).
1 joule per second = 1 watt = 1 ampere @ 1 volt.
1 horse power = 33,000 foot lbs. per min. = 746 watts per minute
Watts = volts × amperes = joules per second.
1 Board of Trade Unit = 1000 watt hours = 1 kilowatt hour.
1 electrical H.P. hour = ·746 unit.
1 kilowatt per hour = 1·34 horse power.
1 „ per minute = 80·45 horse power.

PRESSURE.

1 inch of mercury @ 32° F. = ·034534 kilo per sq. cm.
= 13·596 ins. of water = ·4907 lb. per sq. in.
1 mm. of mercury @ 32° F. = ·0013596 kilo per sq. cm.
1 lb. per sq. in. = 2·0378 ins. of mercury = ·1903 c.c. of mercury.
= 14·223 kilos per sq. cm. = 2·31 ft. head of water.
1 lb. per sq. foot = 4·8826 kilos per sq. metre = ·0708 kilo per sq. cm.
1 kilo per sq. cm. = ·0703 lb. per sq. in.
1 kilo per sq. metre = 4·8826 lbs. per sq. foot.
1 atmosphere = 14·7 lbs. sq. in. = 29·95 ins. of mercury.
= 760 mm. of mercury = 1·054 kilos per sq. cm.
Column of water 1 foot high = ·433 lb. per sq. inch.

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